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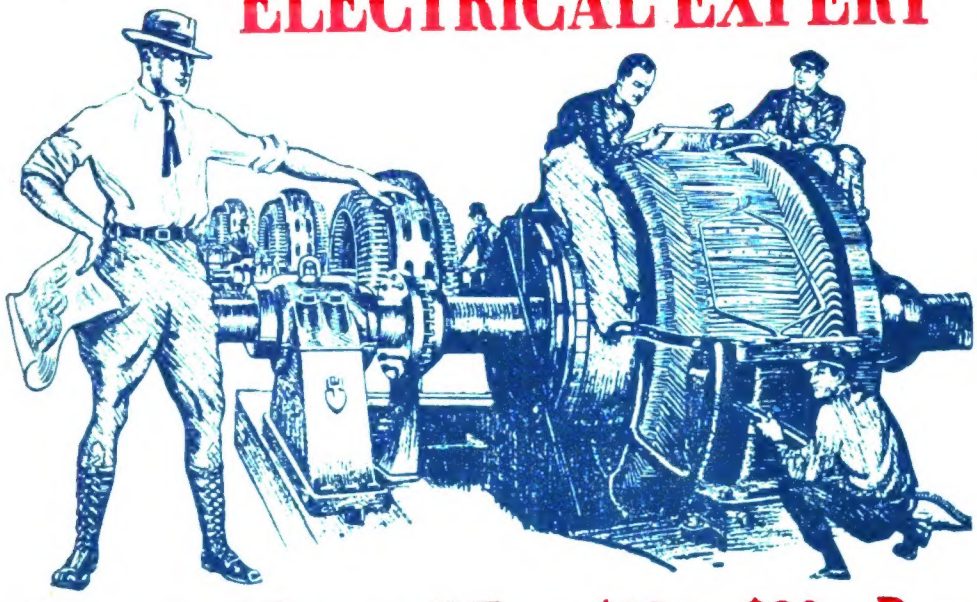

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"I would not take 1,000 dollars and be without your Course. If I did the years ahead would only be like the few that have passed."—H. Swiger, Wallace, West Virginia.

Complete Letters Sent When You Write Me

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Vol. VIII
Whole No. 95

Science and Invention

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The Mysterious Rays

WHEN Röntgen first discovered the X-rays, the discovery provided a sensation not only in scientific circles, but it caught the popular fancy as well. When these mysterious rays were first discovered, the outstanding facts about them were of course their penetration thru the human tissue, and it gave us the means to view the bones in the human body, a thing which before that time had appeared fantastic of accomplishment.

Altho it is now twenty-five years since X-rays have been discovered, we still know very little about them. In some quarters it is maintained that X-rays are not a wave motion of the ether similar to light, but that on the contrary, the rays are really streams of matter shot off at the speed of light. This view, however, does not seem to be upheld lately, mainly for the reason that it has been discovered that X-rays can be refracted in certain crystals similar to light rays, which latter can be refracted by means of prisms and lenses. As time wore on many new wonders became possible by means of the X-ray. It was early found that these rays have the property to ionize, *i.e.*, making electrically conductive the air thru which the rays pass. This quality is shared by radium in a similar manner.

Every day we behold new wonders which are accomplisht by the X-ray in one way or another. Certain diseases for many years have been treated by means of X-rays and cures have been effected on cancerous tissues by these rays as well. Metal castings which have invisible flaws need no longer endanger human life; for instance, our automobile axle may look perfect from the outside, but it may have invisible fissures hidden inside. The X-ray reveals these faults today. Certain insects which infect tobacco are now killed by X-rays. The crates containing the tobacco are subjected to the rays and the insects are killed off in short order. One of the greatest scourges of humanity, insanity, is now indirectly cured by the X-ray. Teeth containing pus were hitherto unsuspected of creating insanity, but they do just that. The X-rays show at once such defective teeth. There are now thousands of recoveries if the teeth are either treated or extracted properly.

By rubbing the finger over metallic powder and taking an X-ray picture, the French police recently found this to be a valuable adjunct to ordinary finger printing. Not only do we thus get the true picture of the skin's lines and whorls, the same as if ink were used, but we get the structure of the bones as well, and these were found to vary just as much as the finger prints themselves.

Oil paintings by old masters are now readily proven genuine or spurious by means of X-rays giving us immediately the true condition of the painting.

Recently X-ray moving pictures have been proposed whereby audiences may witness the most fantastic spectacles ever seen. Instead of seeing the human beings or animals in the flesh, we see only the bones as well as the outlines of the body.

We may safely say that we have only scratched the surface with the X-ray. Every day brings forth new wonders—new applications. It is impossible to draw a line limiting what can be accomplisht by these mysterious rays in their own field, and much is to be hoped for from them during the next few years.

H. GERNSBACK.

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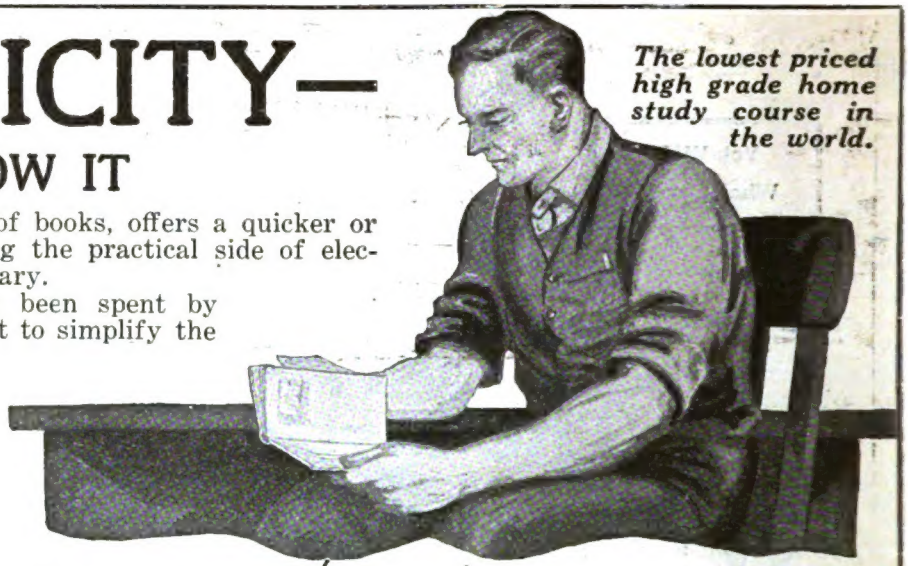

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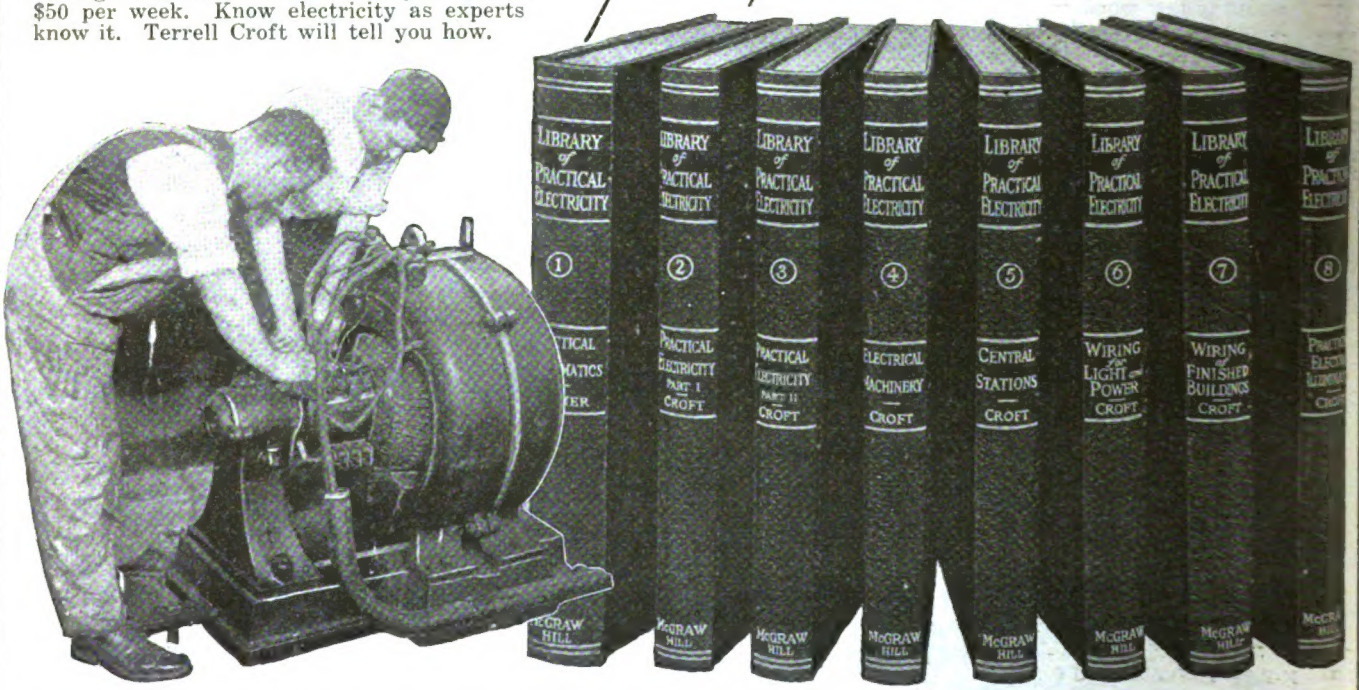

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Volume VIII.
Whole No. 95

Science and Invention

H. GERNSBACK,- EDITOR
H. WINFIELD SECOR,- ASSOCIATE EDITOR
T. O'CONOR SLOANE, Ph.D.,- ASSOCIATE EDITOR

MARCH
1921
No. 11

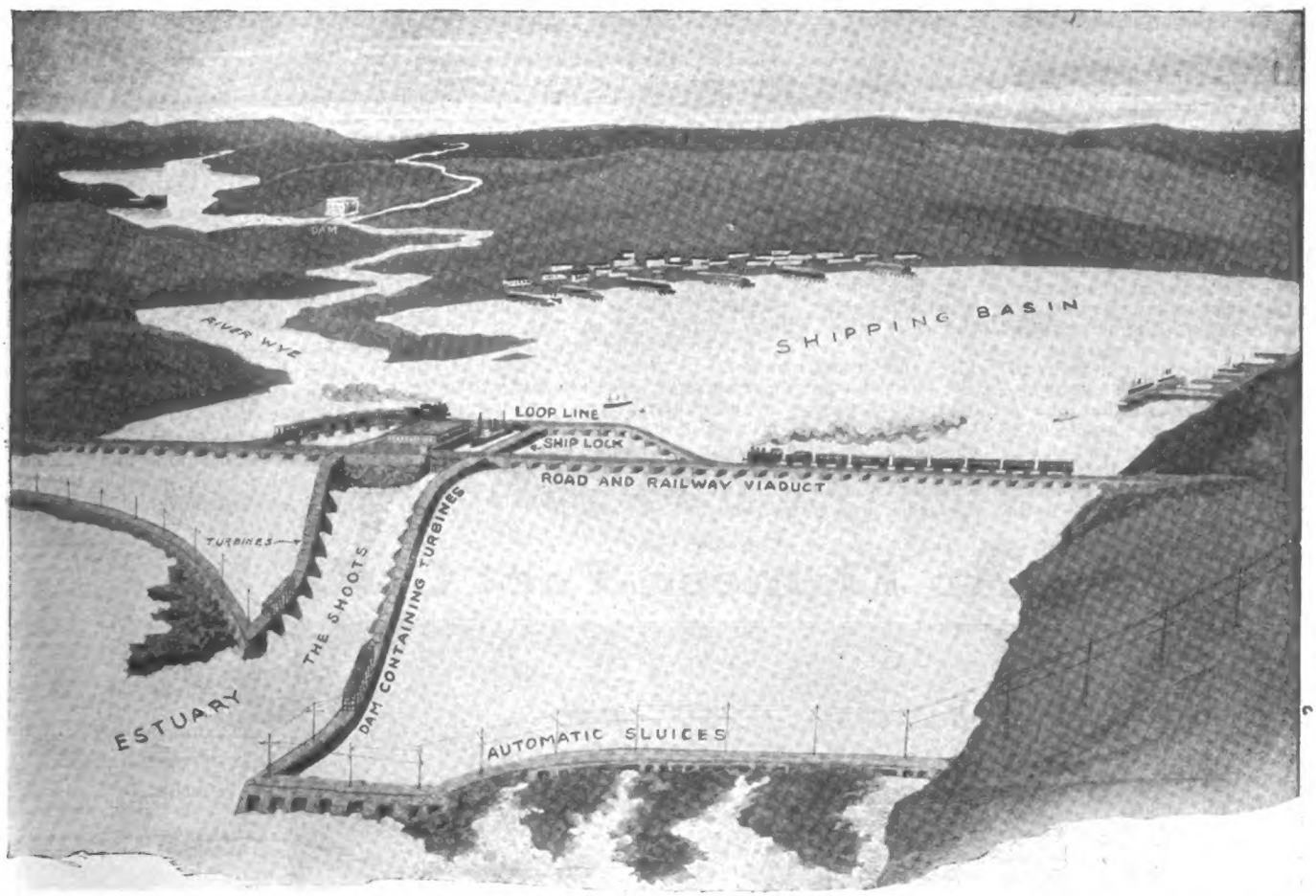
Utilization of Tidal Power in England and France

WE present to our readers, two schemes for utilizing tidal power, the one following the lines of a plan, originating in France, for a power station on the British Channel; the other a proposed installation of a very large size at the mouth of the Severn River, England. The estuary of this river is celebrated for the great rise and fall of tide, which brings about the formation of a bore.

The idea of the French installation is by a system of conduits to admit water to an impounding reservoir as the tide rises. The water entering the reservoir passes thru pipes, and referring to the cut, with valves in the central line open and those in the side lines closed, the water flows in thru the central line actuating turbines in the power house. The course of the water as it passes thru the power station, it will be observed, is from the sea towards the reservoir, so that the turbines rotate in a sense determined by the direction of this flow. When the dam is full and the tide begins to fall, power is again developed by closing the gates in the central line and opening those in the side lines. The effect will be that the reservoir will empty itself and the flow of water thru the power station will be in the same direction, within the station, as it was before. Thus the turbines will always turn in the same sense, whether the tide is entering the reservoir, or whether the reservoir is delivering its contents to the channel.

The idea of the scheme is simply to give the turbines the same direction of rotation, whether the reservoir is filling or emptying itself. The above is perhaps little more than a suggestion but it at least carries out the idea of a uniform direction of rotation of the turbines in the power station.

We now come to the proposed Severn River installation. Taking advantage of any natural shoals the channel is to be dammed with provision of a shiplock plant. The dam whose line is determined by the natural contour of the river bot-



In England There Is Very Great Rise and Fall of the Tide. In the Severn Estuary a Thirty-Foot Rise and Fall Is to Be Utilized As Shown Above. A Half Million Horse-Power Is to Be Developed.

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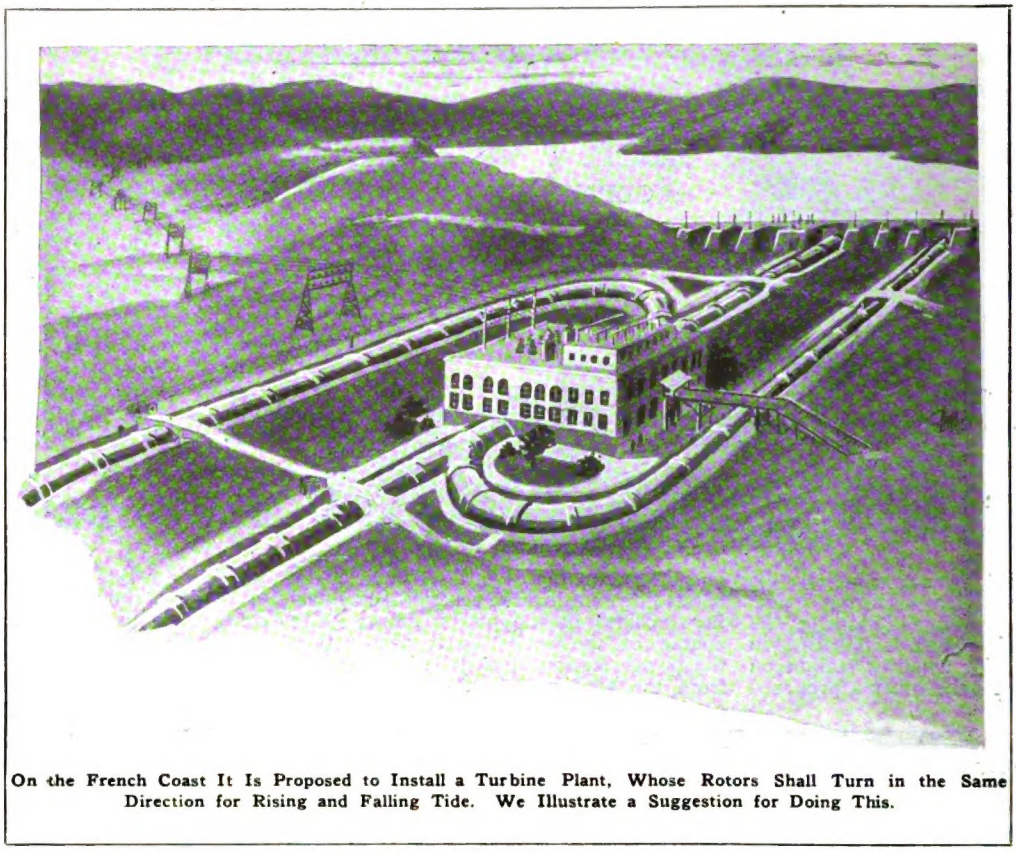
tom, provides, as will be seen from the cut, a wide channel leading to the lock. In the walls forming this channel there are to be installed turbines of a million maximum horse-power. The power which the turbines can develop will vary over a very large range. To the left of the cut is seen the River Wye, beloved by Cook's tourists, and far back in the interior there has been found an ideal site for the establishment of an immense lake or reservoir. This site it is proposed to dam and to connect it with the Wye by a tunnel; when the conditions are such that the turbines are exerting a million horsepower, half of it will be taken off and expended for filling the lake.



On the French Coast It Is Proposed to Install a Turbine Plant, Whose Rotors Shall Turn in the Same Direction for Rising and Falling Tide. We Illustrate a Suggestion for Doing This.

Under other conditions of the tide, when normal conditions would give the turbines very little power, the waters of the lake are to be drawn upon so as to bring the power up to the normal 500,000 horsepower.

Above the dam a railroad bridge and viaduct crosses the estuary. At the locks it is doubled so that one set of tracks passes on the ocean side of the locks and the other on the river side. The object of this arrangement is to give the trains continuous passage. In locking ships thru the gates it will be seen that one track or the other will always be closed. If but a single track crost the locking station it would have to be opened every time a ship went thru, thus introducing the trouble of intermittent passage for trains.

The method of energy storage, involving the use of the artificial lake, contemplates special turbines to be stationed in the vicinity of the lake so that, as the water is allowed to flow into the Wye, these turbines will give the power, which under the conditions of slack water the turbines in the Severn waters cannot supply. It is a most ingenious arrangement and would seem to contain a good suggestion for other similar locations. Offhand, a number of such power stations could be suggested, for on the coast of England, there are several localities which would seem open to this class of treatment.

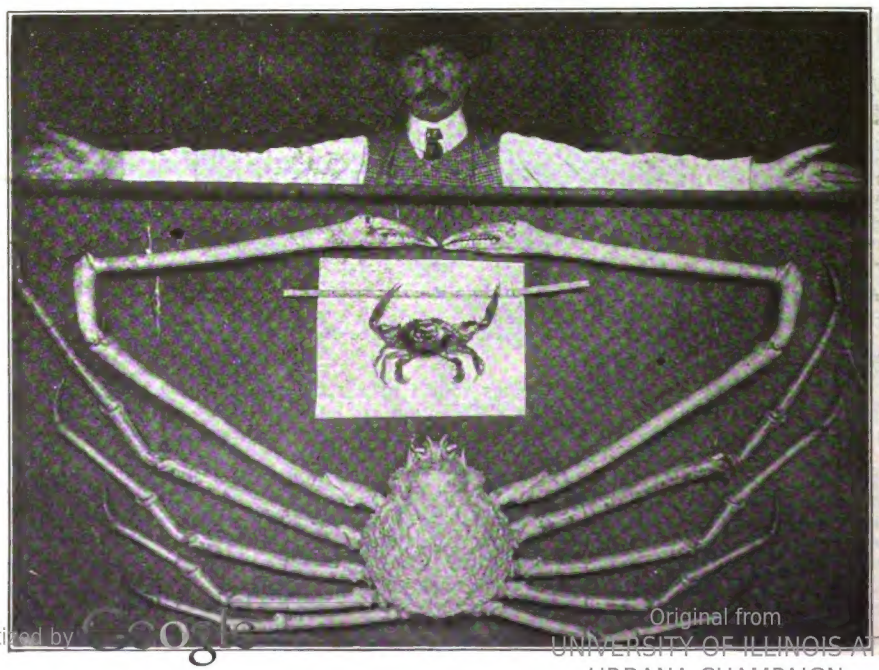
In the case of the "Severn Barrage," as the installation is called, an enormous amount of energy will have to be stored in the lake. The tunnel for its supply is to be driven thru over a mile of solid rock, and is to have a diameter of 40 feet, so as to be the largest thing of its kind in the world.

For such installations as these, if they are to be established on this side of the ocean, one's thoughts go at once to the northeast where in the state of Maine and in the provinces on the Bay of Fundy there are many ideal sites. Our readers will remember the famous waterfall in the Harbor of St. John, New Brunswick. This waterfall falls in opposite directions as the tide changes. Here one of the installations we have described as being designed for the British Channel, might indeed be put into successful operation. For many years, coal has been brought down from the provinces. Perhaps a time will come when power from the ocean will be distributed from the head of the Bay of Fundy where the enormous tidal rise and fall would seem to make possible the construction of an ideal power plant.

An Eighteen-Foot Crab!

HOW would you like to be in swimming at your favorite beach and suddenly find yourself in combat with a gigantic crab like the one shown in the accompanying illustration? This is not a reconstructed crab of prehistoric times, doped out in plaster and wood by a bespectacled theorist or student, but it represents what is said to be the largest crab in the world, and which was found in the sea-waters off Japan.

This enormous creature of the deep has tremendously large arms with pincers, which arms extend eighteen feet. The size of this huge specimen compared with that of an ordinary sized American crab is clearly show in the illustration.



This big crab, in order to escape being killed, when attacked by other large marine inhabitants, proceeds by the aid of his pincers to plaster and cover his whole body with various growths and seaweeds, et cetera, until he resembles a bit of the sea bottom itself, thus evading his pursuers.

The relative size of the giant crab is also demonstrated vividly by its comparison with the man shown standing with arms extended.

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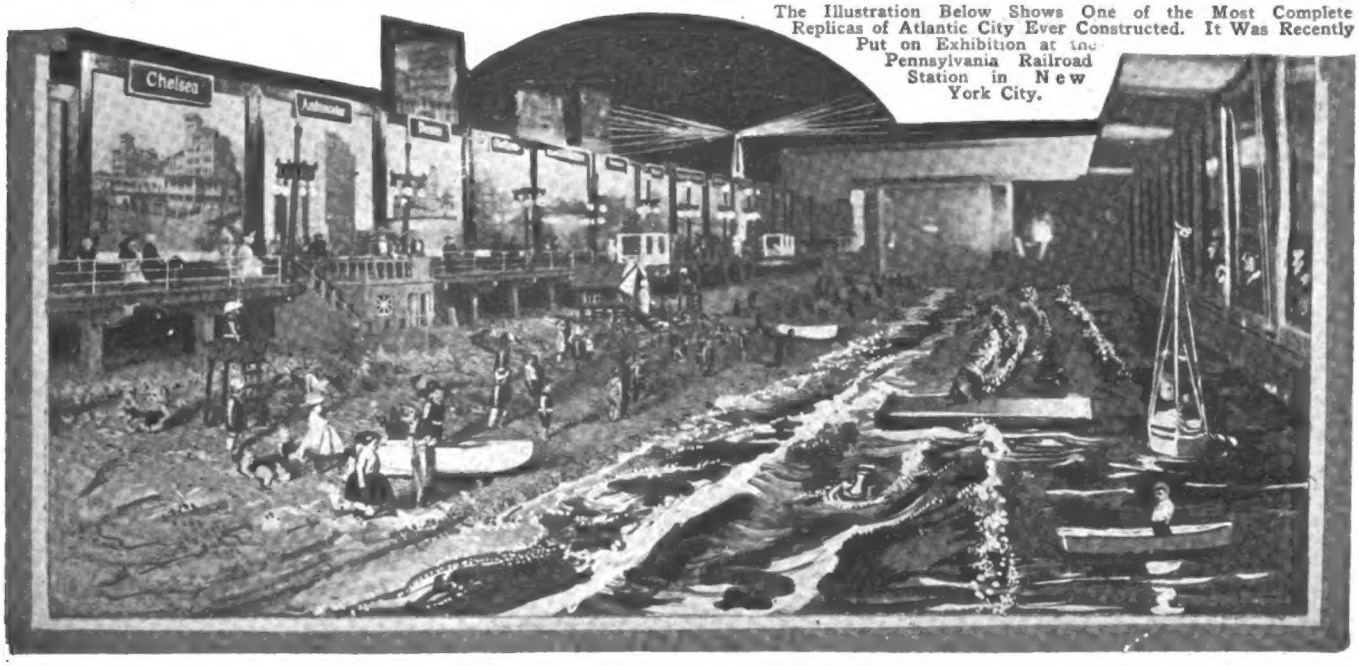
Atlantic City in Miniature

THOSE who like true-to-nature miniatures will surely admire this clever and interesting scene now being exhibited at the Pennsylvania Railroad Station in New York City by the Atlantic City Publicity Bureau.



The Illustration Below Shows One of the Most Complete Replicas of Atlantic City Ever Constructed. It Was Recently Put on Exhibition at the Pennsylvania Railroad Station in New York City.

The display itself is forty feet long and thirteen feet wide and was donated by three Atlantic City Fire Department members. The breakers and boardwalk are faithfully reproduced in exact detail with photographs of the famous Atlantic City hotels making up the background. On the boardwalk four continuous streams of pleasure seekers move along in opposite directions. Here we find miniature dolls, drest in the height of fashion, watching the crowds at the beach, some strolling along and some in wheeling chairs propelled by an attendant. Even their tiny legs move as they travel to their ultimate destination in back of the scenes.

Here they dip under, on an endless belt only to come up on the opposite side and continue their seemingly tireless movements. At the beach are miniature dolls in all kinds of positions; some buried in the sand and some frolicking around. Others again are enjoying the cool inviting waters and dipping under the surface each time the breakers carry them under.

The flood lights are suddenly extinguished and the night scene of Atlantic City boardwalk is rendered in detail, the only illumination coming from the miniature boardwalk lamps and a lighthouse in the background. The waves continue to roll and the bathers remain in the water.

A word as to its construction. Four long endless bands of tape are moving constantly, two in one direction and two in the other. To these bands are attached the miniature dolls 4 or 5 inches high so that their feet and legs depend freely. Into the bottom of each foot a small nail is driven which collides with a series of nails driven laterally into two strips of wood lining each side of the slot enclosing endless tape bands.

The forward motion of the doll causes a movement of each foot exactly similar to a walking movement in a human being. The breakers in the water are made by painted strips of canvas, glued to three rollers which constantly revolve in a tank of water. To these breakers are attached the bathing dolls. The display is valued at $6,000.

Taking a Mask of the Human Face

We illustrate the making of a face mask from a living model. It is anything but a pleasant operation. It is done with plaster-of-Paris put on soft, which in a few minutes sets to a stony hardness.

Oil is used as required to prevent its adherence. It may have to be removed in parts. This is provided for by having a wire bent so as to lie close to the surface along the lines where it is desired to cut the plaster, and by withdrawing the wire, the material is cut so that the mask can be removed in pieces. This gives an intaglio of the features. The pieces are put together, then either treated with oil or wax to prevent adhesion, and as many plaster casts as desired are taken therefrom.

A Plaster-of-Paris Likeness of One of the Most Beautiful Women in France. The Molded Form Was Poured Into a Plaster Mask Taken as Shown at the Right.

Expert Shown Removing One-Half of Plaster-of-Paris Face Mask After It Has "Set" and Hardened. A Wire Placed Over the Face Facilitates Splitting the Mask.

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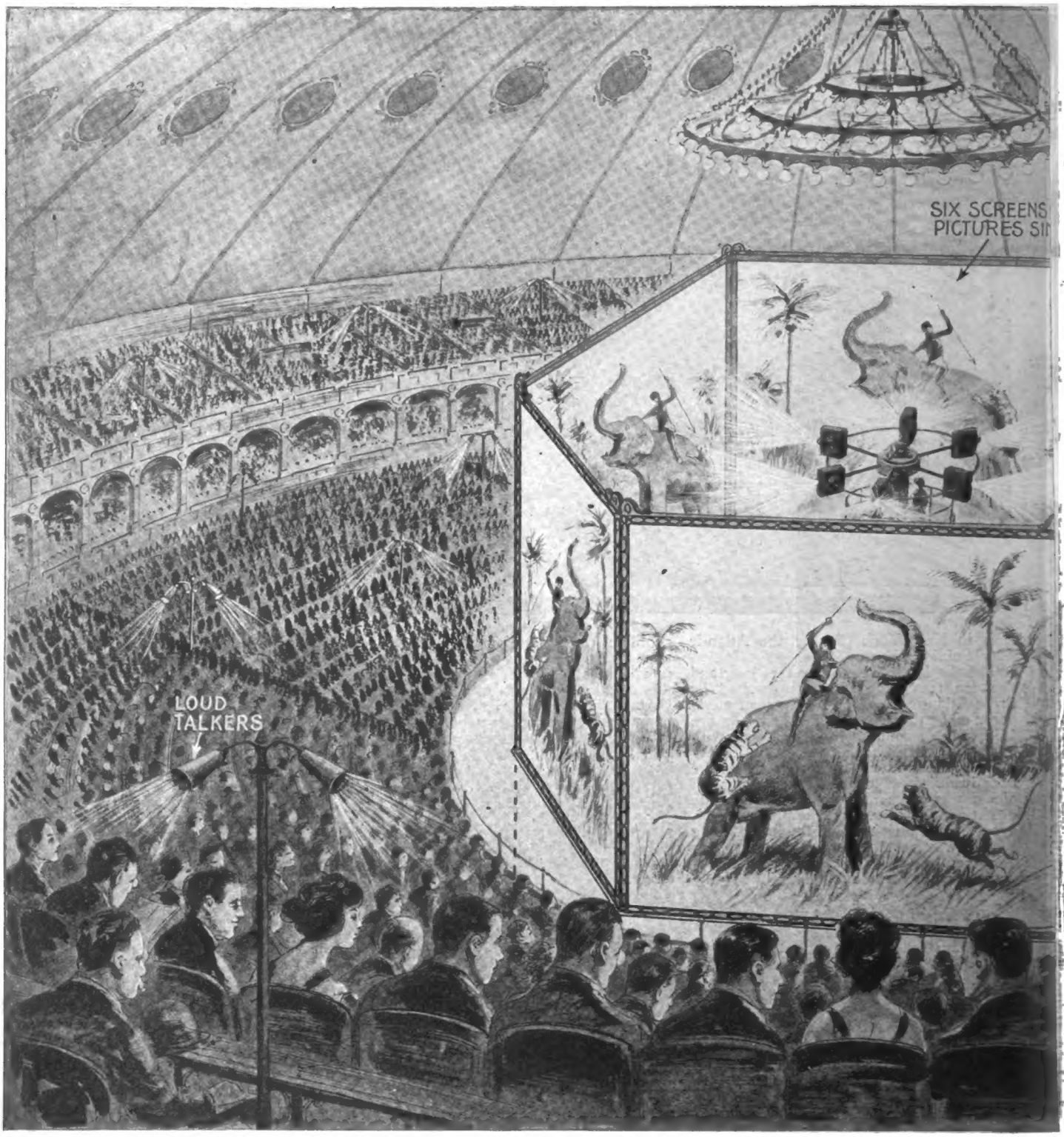

The Above Illustrates a New Idea in Motion-Picture Theater Building Whereby It Becomes Possible for 50,000 People or More to View Motion Pictures. The Idea, in Short, Is to Use a Hexagonal Screen, Which Consists Really of Six Distinct Screens on Which Six Pictures Are Thrown Simultaneously, as Well as Synchronously. The Entire Audience, Therefore, Views the Picture at the Same Time. The Screen Is Arranged So

The Movie Theater of the Future

By H. GERNSBACK

OUR moving picture theaters have increased by leaps and bounds during the past decade as is realized by everyone. In our large cities it is always difficult to seat all the patrons who desire to gain admission, and when a big feature is advertised, it is usually impossible to secure admission, even tho these houses seat anywhere from two thousand to five thousand people at one time.

Take, for instance, the largest picture theater in New York City, the Capitol, which is also the largest theater in the world. This theater has 5,300 seats and quite frequently it is impossible to gain admission; it has been remarked often that this house would be sold out if it were five or six times as large.

What, then, will the future bring? If at the present time we have houses seating more than five thousand people which cannot accommodate the moving picture-loving public, what will happen five or ten years hence when the population has largely increased and when the taste for movies has increased as well?

Built along the lines of the present motion picture houses, that is, on the rectanguar plan, it seems almost impossible to make the houses much larger than the present Capitol Theater. A person sitting in the last row is some 212 feet

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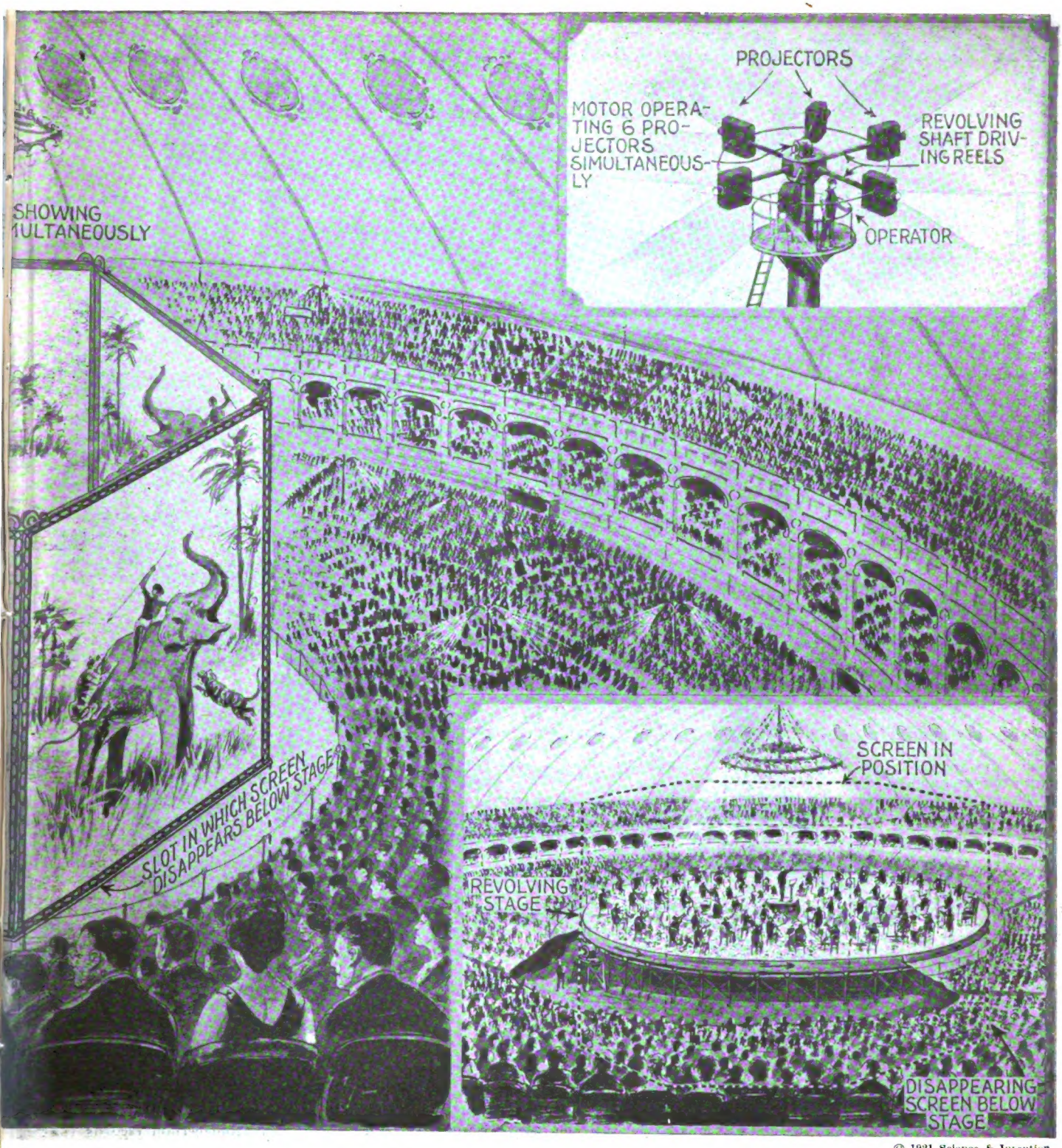

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That It Sinks Below the Floor, Unmasking a Revolving Stage Upon Which the Orchestra Is Seated. The Novelty of the Revolving Stage Will Be Appreciated by All Theater-Goers. New Effects Are Provided by Such a Feature, as Is Made Apparent from Our Article. Loud-Talking Telephones Thruout the Auditorium Make It Possible for Everyone to Hear, Even Tho Seated in the Last Row.

away from the screen, which is about the limit, unless he should wish to use opera glasses, which seems impractical. What then is the solution?

The writer suggests to go back to the old Roman amphitheater construction for moving theater houses, and our illustration shows how it can be accomplisht. A house as pictured here should *seat from forty to fifty thousand people* without much trouble, and it seems reasonable that such a theater would be readily filled and could be run profitably, at least in our larger cities.

Of course, such a scheme precludes the use of a single screen, and for this reason the hexagonal screen arrangement as shown must be used. This screen, which by the way disappears below the floor of the theater (similar to the curtain now used at the New York Hippodrome), is placed in the center of the house. Motion picture projectors, of which there are six, are located in the central axis of the six screens as shown. One operator attends to the six projectors, *all of which run simultaneously and are strictly synchronous as well.* In other words, the identical films are shown simultaneously on the six screens, and the action must be synchronous for the following reasons. Suppose one of the screens should flash a certain comical action ahead of the other five screens. Naturally, the audience sitting in front of this particular screen would start laughing loudly, before the people sitting in front of the other screens had reached that particularly mirthful topic. The other five "audiences" would therefore be annoyed, which can be readily understood. It should be noted that there are really six separate "audiences" to a house of this kind, one "audience" for each screen facing it.

For this reason, it would be of the utmost importance to run the films synchronously, which can be accomplisht with very little trouble by means of a single motor and six revolving shafts which drive the six reels, as seen in our illustration in the upper right-hand corner. If a film of any of the projectors should break, the operator stops all of them until

(*Continued on page* 1218)

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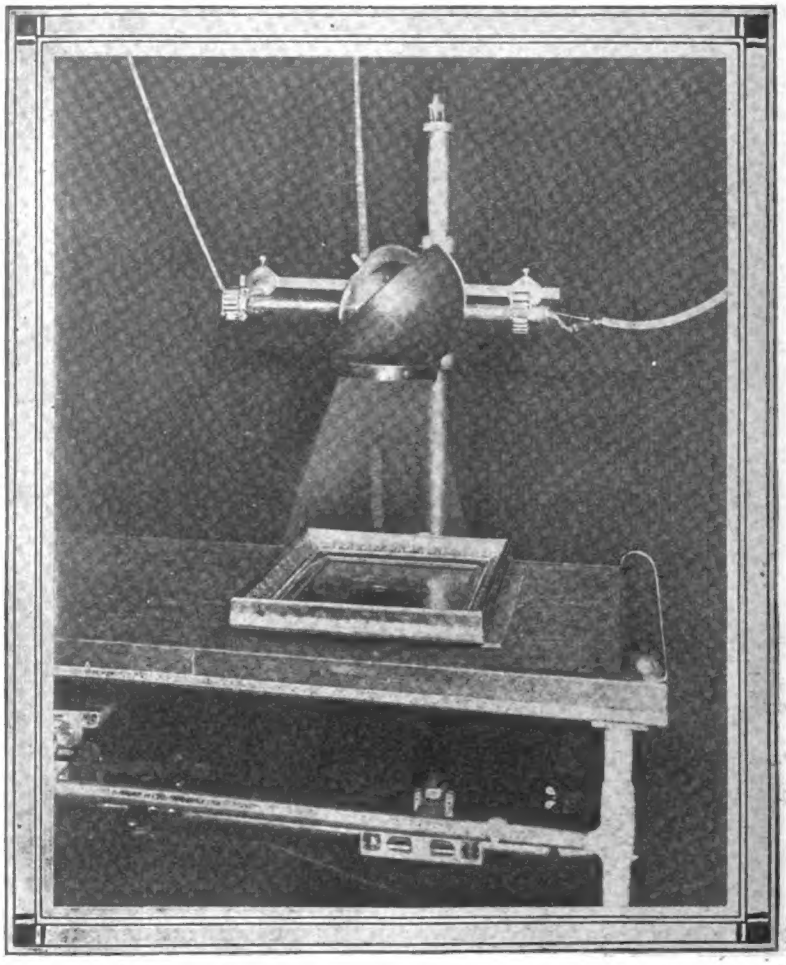
X-Rays Expose Counterfeited "Old Masters"

By JACQUES BOYER

THE rôle of X-rays in the last few years has been almost exclusively medical, but now it seems destined to be extended and to cover a more varied field day by day. The services which it has rendered to metallurgy in revealing imperfections in such metallic parts as may be of particular importance is recognized now; and finally it is invading the domain of the fine arts, so that the world of fine art and painting is destined to utilize its remarkable power.

The first investigations of this nature were carried on in Germany in 1914, and are described by Faber in the *Zeitshrift für Museumkunde*. They have been followed out in Holland by Dr. Heilbron of Amsterdam, who has attained very curious results.

Recently a French specialist, Dr. André Cheron, has attained still more exact results in this field, and we give herewith the technique of his methods which has made possible the radiographic verification of the authenticity of paintings by the "old masters."



X-Ray Apparatus Used Successfully in Exposing Spurious "Old Masters." The Genuine Old Grounds Were Done in Pigments Which Were Comparatively Transparent to the X-Rays.

It is known that the degree of transparency of a body to X-rays depends upon the number and weight of the colors present. Now in a picture there are three things to consider: the support (canvas or wooden panel), the ground with which this support is covered, and finally the colors which are used in the picture itself. The support is always very transparent to X-rays, cloth much more so than wood.

As regards the ground, it seems to follow from the records which we possess on the manufacture of colors and on the preparation of canvas and panels, that the old artists spread over their supports a mixture of calcium carbonate and glue, comparatively transparent to X-rays. Today, on the contrary, a coating of white lead is almost exclusively used, which is much more opaque and which, working into the interior of the threads of the cloth, makes a contrast with the transparency of these threads which cannot escape notice.

As regards the colors used by the artist for depicting his subject, they also vary greatly in density and consequently in transparency to X-rays. Some colors such as white are and always have been almost exclusively made of heavy compounds of lead or of zinc; such colors are practically opaque to the X-ray.

Others, like bitumen and the generality of blacks, are extremely light and let the rays pass thru very readily. Finally, between these two extremes we find very different density or weight, from light carmine to heavy chrome yellow with cobalt blue, ultramarine, sienna, Veronese green, English vermillion and orange, taking the intermediate positions.

But a certain number of colors which were formerly made on a base of mineral salts (the majority of reds, for example) are today sometimes made of vegetable substances far more transparent, like madder. It is the same with aniline colors.

It is clear now that to obtain a good radiographic image of a painting two things are essential: (1) the transparency of the support and of the ground; (2) the relative opacity of the colors or at least of certain of the colors whose contrasts form the image.

These conditions are accurately realized in the ancient paintings; on the contrary, modern paintings on an almost opaque ground, covered with colors, often very transparent to X-rays, give less perfect images by the X-rays and are often almost invisible.

Here is our first result. Radiography can give us a clue to the age of a picture and consequently sometimes can determine its authenticity.

Another result that radiography will show is the injuries which a painting may have experienced in the course of the centuries, in spite of the most skillful restorations. Since it is a question of ancient painting, the ground and the color used in the restoration will be of different manufacture and probably of different atomic weight, and will disclose on the photographic plate by absolute spots, perfectly defined in area, the injuries often entirely unsuspected by the casual observer.

And now perhaps the most interesting of these researches is the revealment of surprises by radiography. To see a picture by transmitted X-rays is to know in great part its history. The artist himself may have modified his work in the course of its execution. All the additions, all of the overlays which have been used on it, are thus revealed; not to mention the unexpected discoveries of paintings entirely hidden under modern work, the latter done by some unscrupulous artist.

The first two proofs obtained by M. Cheron, *The Madonna of Stellas* and *The Flower Piece*, show very well the contrast between the radiograph of an ancient picture and that of a modern one.

The first has colors that are quite strong and the figures can be recognized clearly. But besides there appear at the base of the picture entirely unsuspected restorations of considerable extent. In the second picture, on the contrary, no image is visible except that of the three white flowers, which are the only things done in a color sufficiently opaque to give a silhouette thru the ground of white lead which undoubtedly coated the canvas.

Another painting, the picture of the *Royal Infant at Prayers* of the French School of the fifteenth century, now in the Louvre, was also recently radiographed by Dr. Cheron. The authorities of the Museum consider from certain records that the original base of the picture had suffered considerable deteriorations and that these were hidden, by a uniform black coating; this radiograph confirms their hypothesis.

Finally, another radiograph obtained by the same process shows a little Flemish scene; it had formerly been attributed to van Ostade. The radiograph is still more curious. It shows no trace of the figures, except the head of one of them which can be made out in the center of the painting, but on the contrary, two peacocks, two ducks and two chickens appear upon the plate. There were undoubtedly two paintings superimposed on the same wooden panel; the first, that of the birds, is apparently an antique, since no opaque ground impairs the clearness of the silhouette. The second picture, the counterfeit van Ostade, is probably modern, since the colors, except the whites, are almost uniformly transparent to the X-rays.

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Top: Modern Painting of Flowers at Left; at Right Appears X-ray Photo — the Only Opaque Spots Are Those from the Three White Flowers Done in White Lead, a Metallic Pigment.

Center: Left —What Appears to Be a "Perfect" Old Master Is Revealed by the X-ray as Being in Reality a Restored Painting. The Lower Photos Show Modern Scene Painted Over Older Painting.

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World's Smallest 'Plane

By the Paris Correspondent of "SCIENCE AND INVENTION"

The Accompanying Photographs Show What Is Probably One of th Most Successful and Smallest Airplanes in the World. It Was Designed and Constructed by Mr. de Pischof of France. This "Baby" 'Plane Measures 17 Feet Wide by 11 Feet Long and Stands But 4 Feet, 2 Inches High. Its Speed Is 60 Miles Per Hour When Driven by Its 16 Horse-Power, Opposed Two-Cylinder Engine.

MANY people have been waiting for the small airplane of low horsepower, which will be cheap to run. An engineer, Mr. de Pischof, has built for them an *avionette*. This constructor is a practical aviator and has studied aerodynamics and built successful airplanes ever since the early days of aviation. The first de Pischof machine was built in 1907 in connection with Mr. Koecklin and an *autoplane* was constructed in 1911.

In size they are among the smallest airplanes in the world—in construction, the simplest ever designed. This sport machine flew, during the tests, most successfully. Its construction is entirely metallic and this small airplane is fitted with a 16 horse-power Clerget-Blin horizontal opposed two-cylinder engine built specially as an airplane engine.

The span is 17 feet and the total length is 11 feet, while the height is 4 ft. 2 in.

It is a remarkable fact that this *avionette* can be completely dismantled in a few minutes by the aid of but one small spanner wrench and a pair of pliers. When the wings are folded the width of the plane is reduced to 3 feet. It follows that any small shed will shelter this machine, as, when folded it is no more cumbersome than a light motor car.

The wheels of the undercarriage are mounted on the longerons of the lower wing.

The total wing area is 80¾ sq. ft. When empty, the *avionette* weighs 225 lbs.; its maximum speed is 60 miles an hour and its *ceiling* or highest altitude is placed at 6,520 feet.

Four Rooms in One

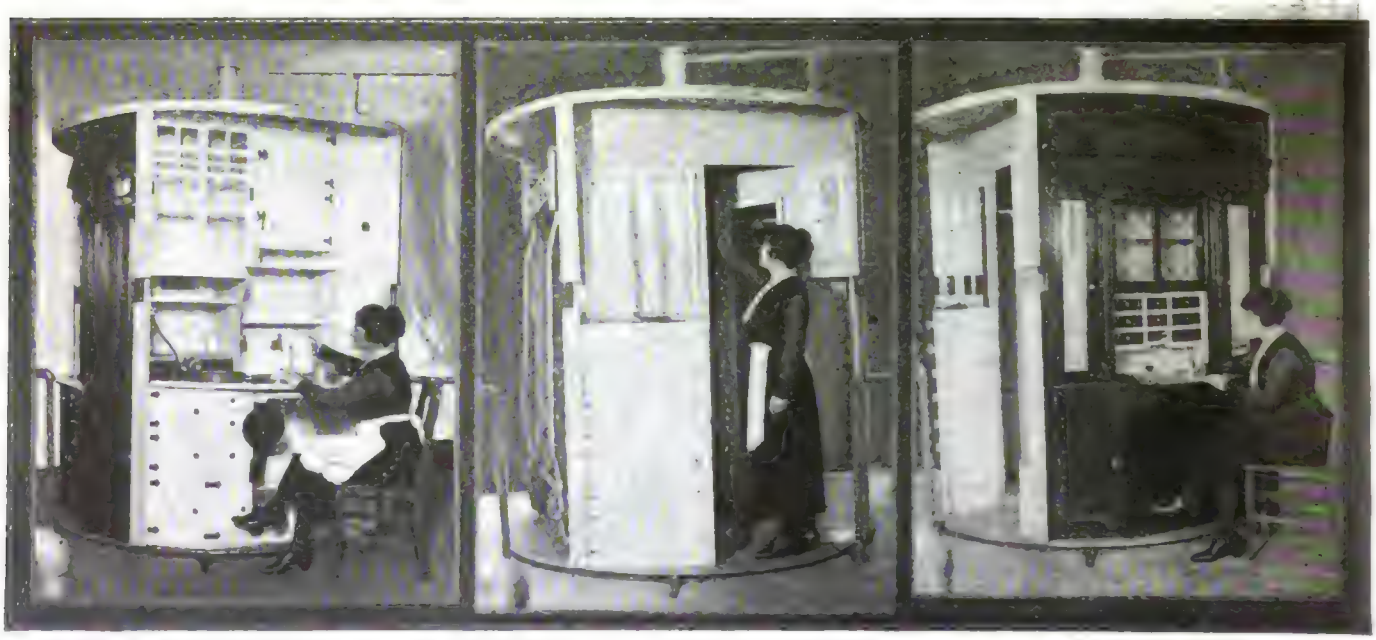
"U-TURN-IT" makes four rooms out of one! Those who live in the congested cities such as New York, where the rents are climbing rapidly "towards the fourth dimension," will find of special interest this latest invention which comprises four living rooms in a small revolving cabinet, the whole affair being about the size of the ordinary pantry.

One Mr. P. L. Cimini is responsible for this invention, which has met with a great deal of favor on the part of the public who have seen the device while on exhibition on Broadway, New York City, recently.

The revolving four-in-one apartment comprises a substantially built revolving cylinder which can be fitted into a corner or into the side of a single room, if that is all the space available, and which will permit the owner to transform this single room at will into a library, a wardrobe, a bedroom or a kitchen, all of which are excellently designed as attested by the accompanying photographs of the invention.

There are four compartments to the cylinder, one containing a bed and bedroom accessories; another a bookcase and library equipment; another a wardrobe, and the last—the most important of the lot, in many ways—a perfect kitchenette, which includes a stove and even a sink.

A simple turn revolves the cylinder and changes the room—*pronto*. This circular combination apartment is well ventilated and may also ventilate the room in which it is placed. The kitchenette is cleverly designed so as to meet practically every requirement of Mrs. Newlywed, and there is a place for everything, provided everything is kept in its place! There are cute little compartments, or drawers, for the flour, the sugar, the spices, etc.



The Complete Kitchenette. **Wardrobe and Folding Bed at Side.** **The Library, Including Desk and Bookcase.**

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The Anatomy of Crystals

FREQUENTLY in solutions of solids, such as those of salt, sugar, alum, borax and of innumerable chemical compounds, symmetrically and characteristically shaped solids appear on evaporation, and by taking special precaution, very beautiful examples can be obtained. Then, if we depart from easily managed solutions such as made in the laboratory, and go into the field of Nature, we find there other crystals, in many cases formed by processes quite unknown to us, and hardly susceptible of surmise; among such are crystals of carbon—as the diamond, of common alumina or clay—such as the ruby, or lead sulfid—*i. e.*, galena or galenite, and so on thru a myriad of minerals.

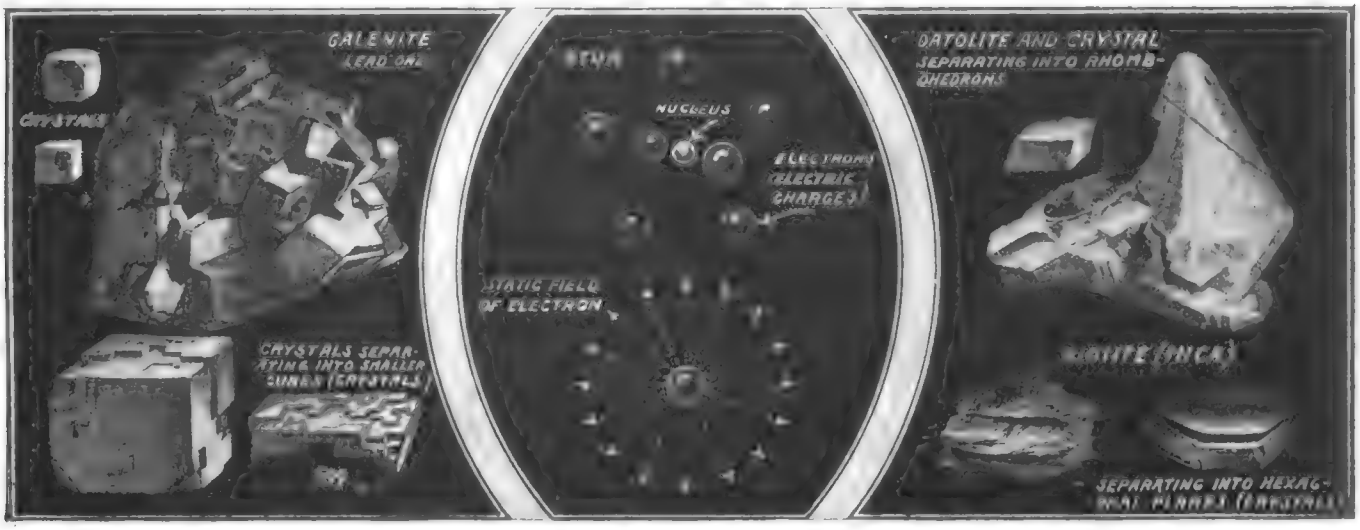
as the first or isometric system. Then come four other systems whose axes are not all of identical length, but each of which has its three axes. In the second system they intersect at one point at right angles and only two of them are of identical length. In the third system, the axes are of different lengths, but still intersect at right angles. In the fourth and fifth systems, at the point of intersection, the axes which are of varying lengths, intersect at oblique or obtuse angles. So far there have always been three axes to a crystal.

Finally, in the sixth system, there are four axes, three of them lying in a transverse plane to the length of the crystal and intersecting at angles of 60 degrees, while the fourth axis passes thru

eral readily splitting away in faces parallel to those of its proper cubic crystal. By keeping it up, we can get a collection of almost microscopic cubes.

Again, we show mica, cleaving into sheets, transverse to the longitudinal axis of its crystals. In this mineral, we have only one prominent direction of cleavage. It would be very hard to find in mica, any other cleavage plane than that transverse to its longitudinal axis or in crystalogical terms—parallel to its base. Thus, Nature may give us a hexagonal prism of mica, and by utilizing its extraordinary cleaving, it may be made into sheets of almost microscopic thinness.

One of the illustrations shows a rhombohedron; the axes of this crystal are inclined one to the other. This is the



The Story of Crystals. Galenite, Datolite and Biotite Mica, As Typical Mineral Crystals, Formed in the Mysterious Laboratory of Nature. Suggested Symmetrical Crystal Building and Forms of Molecules. Those Interested in the Various Systems of Crystal Formation May Refer to the Article Appearing on Another Page, By Prof. F. L. Darrow, Which Contains a Diagram Showing All of the Systems. Contrary to Popular Opinion, Perhaps, the Method or Exact Way in Which Crystals Form Is Not Even Yet Thoroly Understood by Chemists, and Examination Under the Most Powerful Microscope Fails to Disclose the Exact Process By Which Dame Nature Proceeds to Build Up Crystallic Structures Which Outdo Anything That Man Has Accomplished.

Illustrations by William M. Butterfield.

In many cases a large crystal by mechanical means may be reduced to small ones, by a process of division, approximating to pulverization. The famous Abbé Haüy, the French mineralogist, early in the last century, placed crystallography upon a scientific basis. He found that crystals could be divided into six systems. Of these systems, five were definable by the relations of three axes in each crystal.

We have spoken of galenite crystals. These crystals are primarily cubes, and the axes of a cube are taken as being three in number, at right angles to each other, intersecting at a point in the center and terminating in the centers of the six faces of the cube, and therefore of equal length.

All crystals which can be referred to three such axes, belong to what is known

the intersection and is perpendicular to the plane which they determine. Such is a very brief resumé of the six system classification of crystals.

Every crystal that exists can be referred absolutely to one or the other of these systems, altho cases may occur when by some force crystals have been twisted or distorted, but the distortion is so easily recognized as such, that these instances do not invalidate the wonderfully simple laws effected by these products of Nature.

In many cases, crystals have what are known as cleavage planes. This means that they can be divided along the area of such planes so as produce a new crystalline face. We illustrate the result of this operation herewich. In a crystal of the first system, like galenite, it will be seen how cleavage occurs, the hard min-

crystalline form of datolite. Innumerable other examples of crystals could be given. The planetary disposition of nuclei and electrons in the atom which is generally accepted by theorists is sometimes taken as giving a base for the theory of crystals. In referring to the cut, a nucleus is shown with its electrons around it, and it is certainly suggestive of the possibility of geometrically shaped space being filled with the atoms building up symmetrical molecules and in the other views, the idea is carried out still further.

It is fair to say that in different scientific lines, few subjects are at once so fascinating and so wonderful in their exact mathematical relations and also simplicity as crystallography.

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X-Ray Movies--Why Not?

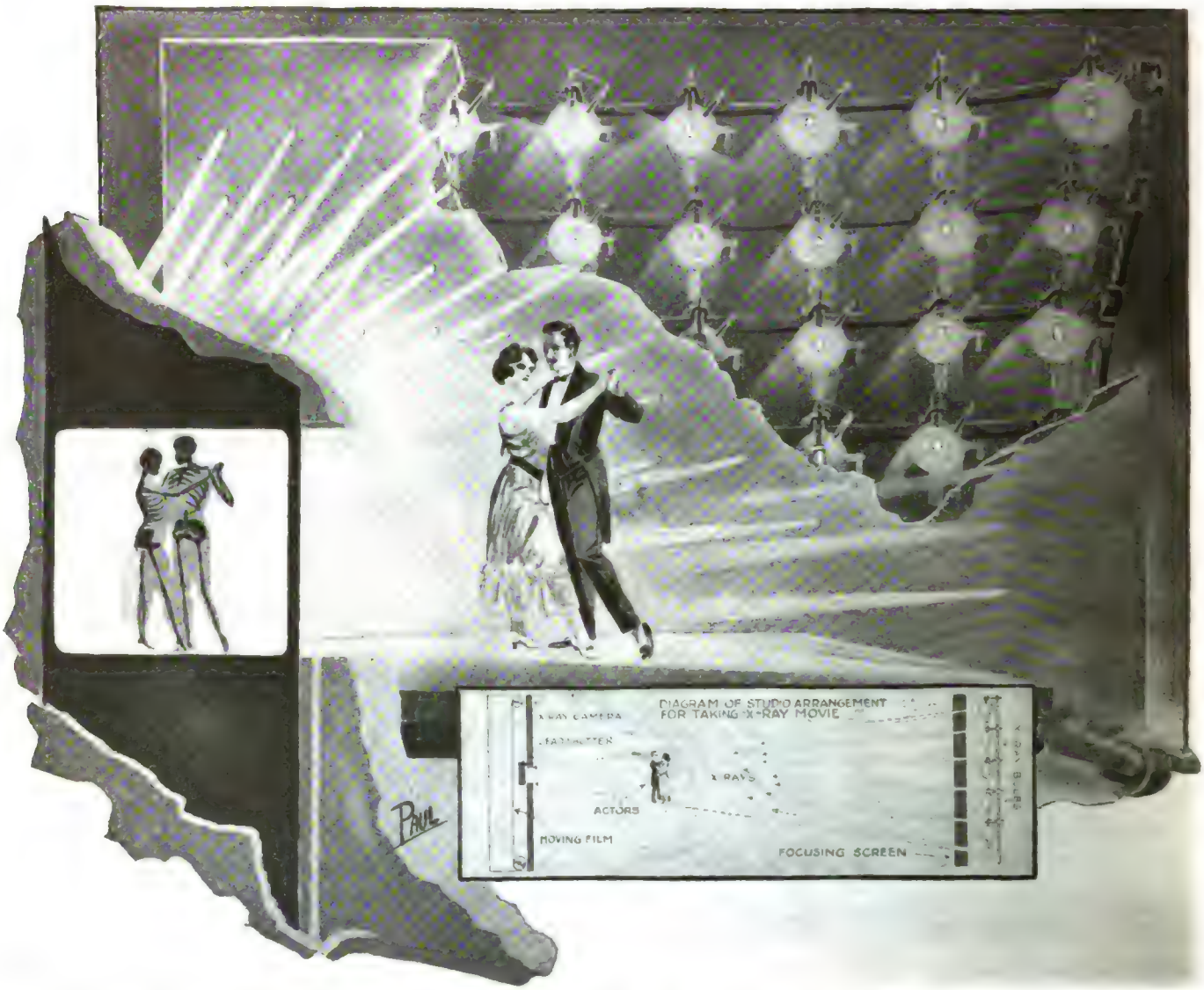
By PROF. HAROLD F. RICHARDS, PH. D.

THE ability of X-rays to penetrate bodies thru which light cannot pass is being utilized in a variety of ways, but certainly no one will affirm that a limit to their applications has been reached. Surgeons in every large hospital in the country are constantly taking X-ray photographs of fractured bones and of bullets and other foreign bodies lodged in the flesh. Few modern dentists extract infected teeth or impacted molars without first examining the interior of the gums with the X-ray. Fluoroscopic examination of the stomach and lungs is a commonplace; the beating of the heart and the peristalsis of the stomach can be made visible to the naked eye; the whole course of a meal thru the alimentary tract can be followed if certain devices are employed. Research hospitals in the East are now earnestly engaged in accurate determination of the exact utility of the X-ray in the treatment of cancer. Great steel and iron manufactories regularly use the X-ray to reveal the location of faults deep within the metal and are thus able to guard against hidden defects that might result in the collapse of a structure.

X-Ray Movie Dramas

There remains at least one field, however, to which it seems possible to apply the X-ray, and that is to the amusement of the public. Formerly it seemed weird enough merely to view a photograph of the bones of the body, but that is not unusual nowadays, and to many people there is nothing particularly novel in actually watching the heart beat or the stomach rock a meal into physical energy. But if X-ray "stills" can be made without trouble, why can we not have X-ray movies? *I purpose in the following paragraphs to suggest a possible means by which X-ray movies can be produced and to point out as well the difficulties that must be surmounted.*

The imagination of the reader will have no difficulty in picturing at once the wonderfully bizarre effects that could be obtained with the utilization of X-rays in the movie industry. The actors will all be skeletons, and at the will of the director the bones can be shown either sharp and unclothed or enveloped with a filmy shadow representing their fleshly contour. The settings will be seen only in part, for tapestries, curtains, bed clothing, thin furniture of wood and all other light objects will not register at all, and the actors will appear as animated skeletons flitting thru a mystic world of sombre shade in which chairs and interior partitions and tobacco pipes are vaguely defined as faint shadows, while steel joists, water conduits and kitchen pans will stand out sharp and clear. The audience will see the revolver in the villain's hip pocket whether the hero does or not, and will tell at a glance whether the door is really locked. When the hero returns from war and blandly announces to his lady that he still bears a machine-gun bullet in his thigh, the audience will know whether he is telling the truth.



Professor Richards Here Shows Us How It Is Readily Possible to Produce "X-Ray Movie" Dramas and Comedies, Utilizing a Bank of Powerful Coolidge X-Ray Tubes As Shown. He Concentrates the X-Rays from the Bank of Tubes by Directing Each Bundle of Rays Thru a Hole in a Lead Screen, Lead Being Opaque to These Rays. Imagine an X-Ray Movie of a "Love Scene!"

A Love Scene in X-Ray Drama

The "movie fan" will enjoy going into his favorite film house and seeing two

(*Continued on page* 1224)

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How We Feel

By JOSEPH H. KRAUS

DID you ever stop to consider how numerous and varied are the senses which you perceive directly thru the skin? Those several qualities of sensation relating to the sense of touch and including that of discrimination, the sense of temperature and the sense of pain? A careful investigation of the skin surface bears out the idea that these three great classes of cutaneous (skin) sensations have special mechanisms or classes of mechanisms for each individual sense.

In considering these senses, it is best to take them up and deal with each separately. Thru the agency of the skin and the touch-corpuscles, we are able to perceive various qualities such as shape, texture and hardness of the objects in contact with the skin.

Of course, the sense of hardness also has associated with it a muscular sense, in that we are able to tell the hardness of the object by pressure. But, the real sense of touch can be easily found and so can the location of the touch spots by a very simple experiment which anyone can perform.

Relation of Touch to Pressure

If a hair is mounted on a wooden handle with a small piece of sealing wax and the skin prest with this hair until the hair bends, then a certain known pressure is being applied to the skin. The skin is then gone over carefully with this hair and wherever a touch sense is indicated we feel the hair touching the skin, a tiny cross or dot is placed on a chart.

The pressure applied by the hair is then determined by pressing down upon a balance which will register the number of grams-pressure a hair of that thickness can give, because the hair will bend at a certain point and the point of bending will give us the weight the hair is capable of applying.

It appears to matter very little whether the surface of the skin is pushed downward or pulled upward by an instrument. A sense of pressure in either case is announced to the brain. We find that on the tongue and nose, a pressure of only 2 grams per square millimeter will announce to the brain that a certain region is being touched.

On the back of the forearm, it requires a pressure of 33 grams per square millimeter and on the back of a finger, only 5 grams. Nearly all pressure sensation localizes itself near a hair root, and in

(*Continued on page* 1248)

SENSE OF FEELING

In Our Center Diagram, We Show Several of the Sense Impressions Which Are Conveyed to the Brain. The Girl by Placing Her Foot Into Water, Experiences the Sense of Coolness from the Water, and Also a Slight Sense of Pressure When Thrusting Her Foot Into It. She Can Tell She Is Sitting on a Rock by the Sense of Touch and Altho a Certain Sense of Pressure Is Due to the Clothes Which She Is Wearing, She No Longer Experiences This Pressure, Because She Has Become Accustomed to the Clothes, So We Say. On the Left, We Show the Distribution of Touch Corpuscles in the Section of Human Skin and on the Right, the Termination of Nerves in One of These Touch Corpuscles. Notice How Well Distributed the Nerve Endings Are.

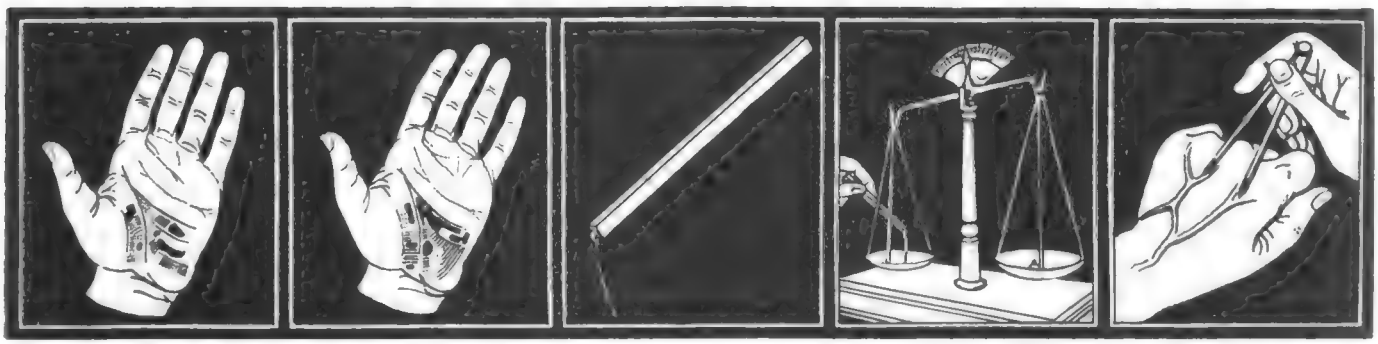

Fig. 1—Heat Spots on a Small Portion of the Palm of the Hand Are Shown by the Blackened Areas. Those Areas Black-lined Are Less Sensitive and Those Dotted, Very Slightly Sensitive to Heat. The Unshaded Sections of the Small Portion of the Palm Are Non-Sensitive to Heat.

Fig. 2—Cold Spots—The Blackened Areas Are More Sensitive Than the Lined Portions and the Latter More Sensitive Than the Dotted Ones. The Unshaded Parts Are Not Sensitive to Cold Sensations. The Reader Can Easily Map Out the Areas as Shown Above on the Hands of His Friends.

Fig. 3—A Hair Mounted on a Wooden Handle with a Piece of Sealing Wax for Determining the Minimum Amount of Pressure Necessarily Applied Before a Sensation Is Evoked. Different Thicknesses of Hair Should Be Mounted on Individual Handles and Each One Specifically Marked.

Fig. 4—Method of Determining the Amount of Pressure Produced by the Hair, by Pressing It Down into One Pan of a Delicate Balance. The Hair Bends and the Point of Bending Will Give Us the Degree of Pressure Applied by the Hair. Various Thicknesses Give Us Different Pressures.

Fig. 5—A Draftsman's Compass Fitted with Two Cork Tips Enables Us to Determine the Distance Between the Points Necessary to Produce the Sensation of Discrimination. If This Distance Be Very Small, a Sensation of Two Points Is Not Obtained.

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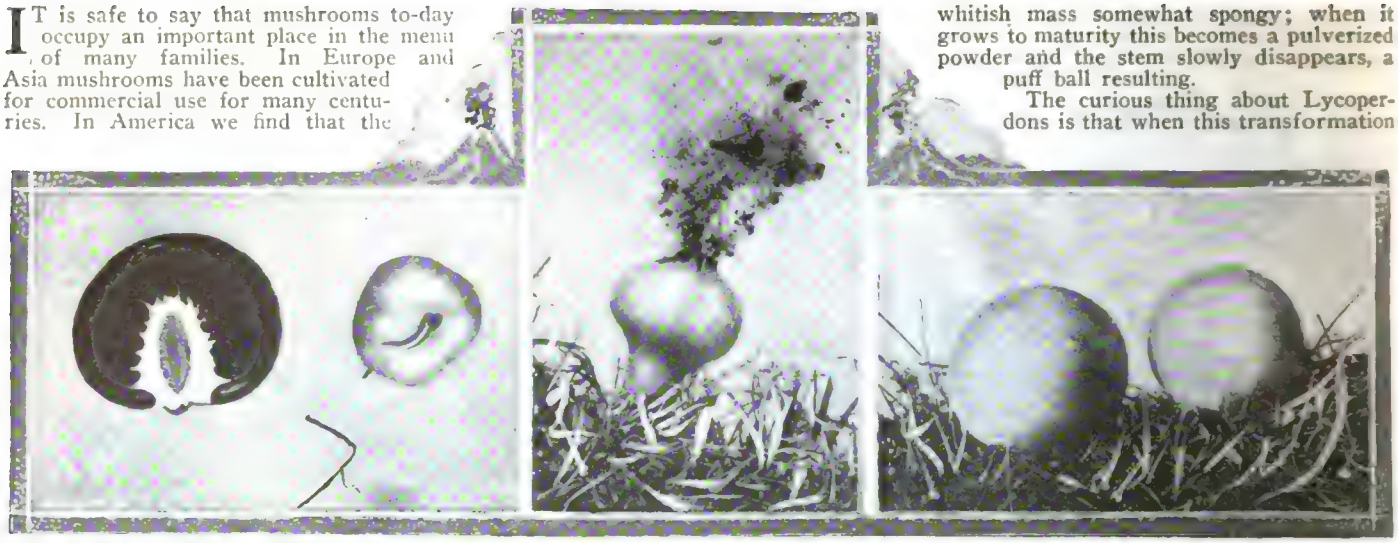
Mushrooms That Explode

IT is safe to say that mushrooms to-day occupy an important place in the menu of many families. In Europe and Asia mushrooms have been cultivated for commercial use for many centuries. In America we find that the mushroom industry is growing by leaps and bounds.

Many varieties of this edible fungus are known to almost every one. Probably one variety known as Lycoperdons or *Explosive Mushrooms* is known to few observers.



A Sectional View of the Lycoperdon or Exploding Mushroom, with an Interior Formation Similar to a Shrapnel Shell.

This Remarkable Photograph Was Taken at the Instant When a Lycoperdon Mushroom Exploded.

Two Full-Grown Lycoperdons with Powdery Surfaces. When Young These Mushrooms Are Edible.

This interesting specimen abounds in Europe over a great area. They are easily recognized if one takes pains to look for them; when they are young they are very edible for table use, their form is spherical, when young the interior contains a whitish mass somewhat spongy; when it grows to maturity this becomes a pulverized powder and the stem slowly disappears, a puff ball resulting.

The curious thing about Lycoperdons is that when this transformation takes place the summit of the sphere breaks open with slightly audible noise when strong sun-rays strike it, a veritable explosion takes place, a cloud of powder is thrown into the air like a volcano giving it the name of *Pacific Crater.*

Why We Grow Bald

By DAVID J. CALICCHIO, M. D.

MY hair is falling out! My hair is getting thin! I am getting bald!" These sentences are repeated every day by millions of people. Your hair can be prevented from falling out. And it is easy to do so, as soon as you will learn, thru the following lines, the cause that makes the hair fall out. The cause itself is plain and easily understood.

Every hair consists of two parts. One part is imbedded in a small pit of the skin, which part is called the root of the hair. The other extending above the skin is known as the shaft of the hair.

The root of the hair is an outgrowth of flesh (hair papilla) underneath the skin. This root is abundantly supplied with small tubes (capillaries) carrying blood to the terminal parts of the body. This blood bathes and feeds the hair.

The blood is as useful to the hair as water is to flowers. Now, when the blood is hindered from reaching the root of the hair, the hair is deprived of its nourishment; it then dies and falls out.

Every part of the body is supplied with tubes (arteries) carrying blood, which arteries divide towards their extremities. The arteries carry food all over the body.

The scalp has four main arteries, two on each side of the head. One artery ascends on the left, the other on the right side.

One artery passes upward from the neck over the lower jaw (mandible) in front of the ear, while the other artery goes upward behind the ear.

As these arteries branch toward the top of the head (sinciput), they divide into smaller and smaller branches like that of a tree, and cover the entire head.

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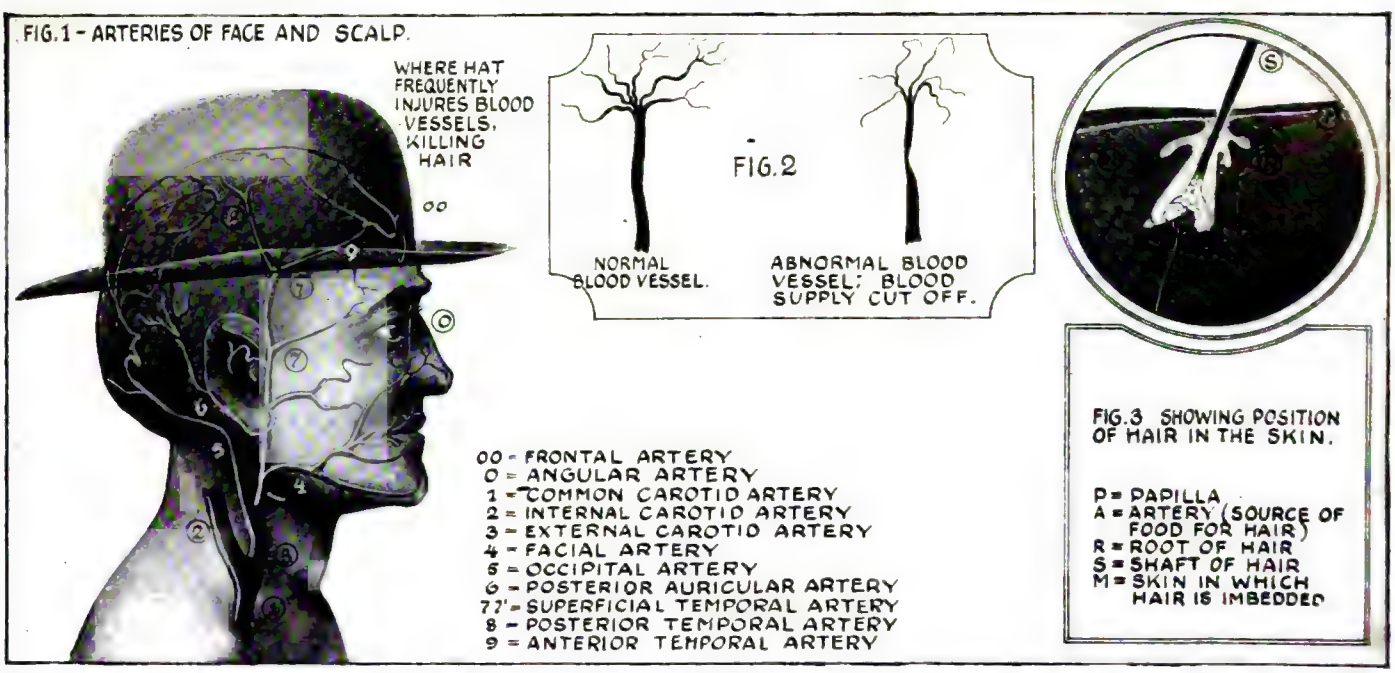

Why Human Hair Has a Tendency to Fall Out at the Top of the Head and Not at the Sides Is Explained in Plain English in the Accompanying Article and Illustraton by Dr. Calicchio. It Is an Oft Repeated Fact That the Constant Wearing of a Hat Will Be Liable to Cause Partial Baldness or Loss of Hair, and This Is Not Merely a Mistaken Idea Handed Down from Generation to Generation, but Is Founded Upon Strict Physiological Facts, Which Are Apparent When We Once Stop to Consider How a Hat May Injure the Blood Vessels Circulating Thru the Scalp Covering the Head. These Vessels Supply the Hair Roots with Nourishment. Injure These Blood Vessels, and Your Hair Is in Jeopardy.

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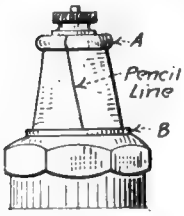
MOTOR HINTS

HOW TO PREVENT THEFT OF CAR

First Prize $25.00.

Here is an extremely simple way to "lock" a motor, for preventing theft and it also is a good joke to play on someone that "knows-it-all" about the car.



The entire apparatus required is a fairly soft lead pencil. Simply mark each spark-plug on the porcelain from A to B, as per illustration—thereby short-circuiting the plug.

When the motor is to be started, twist the thumb and forefinger around the porcelain, rubbing out the mark, and the plug will work as well as ever.

Don't attempt to mark a plug when the motor is running, unless you "enjoy" high tension shocks.

Contributed by R. J. CURTIS.

AUTOMATIC AIR VALVE

Second Prize $15.00.

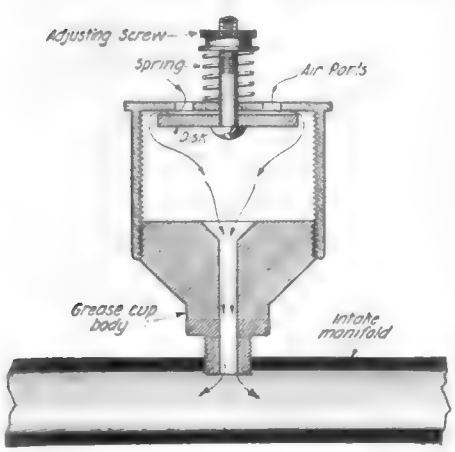
At high speeds the automobile engine works most efficiently on a lean mixture due chiefly to the fact that the duration of the explosion stroke is so small the burning of the mixture must be extremely rapid or most of the power will be lost. This condition is rarely achieved with a carburetor alone so some other device is necessary to admit additional air to give a lean mixture.

A simple and effective air valve can be made from a grease cup and a few odds and ends. A circle of ¼ inch holes is drilled in the cap of the cup, a center hole being provided to pass the stem of the movable member. The latter is a disk of iron or brass with a long 8/32 bolt thru the center. A large washer and thumb screw serves to regulate the pressure of a light coil spring.

This completes the valve. It is to be mounted in the intake manifold at any convenient place. The engine is started and the tension on the spring adjusted so the valve opens when an engine speed equivalent to about 30 miles per hour is attained.

This valve results in a saving in gasoline, reduction of carbon and gives the engine a snappy action instead of the sluggishness noted when an over-rich mixture is used at high speed. It will not affect the operation of the engine when working under heavy loads at open throttle.

Contributed by THOMAS W. BENSON.



A Simple Home-Made Air Valve of the Automatic Type for Insertion in the Intake Manifold.

$50.00 IN PRIZES

Paid for "Motor Hints."

Most of our readers have a car of their own, and any number of them have made certain improvements on that car. We want to know about these improvements. What we want are PRACTICAL ideas, not freak stunts. The idea should be simple enough, so that anyone handy with tools can duplicate it. Note that the idea does not necessarily have to be electrical in any way.

We would like to have a photograph of the stunt showing that it was actually tried, but this is not absolutely necessary to win a prize. A simple sketch will do showing the essential parts, etc.

We will pay the following prizes each month:

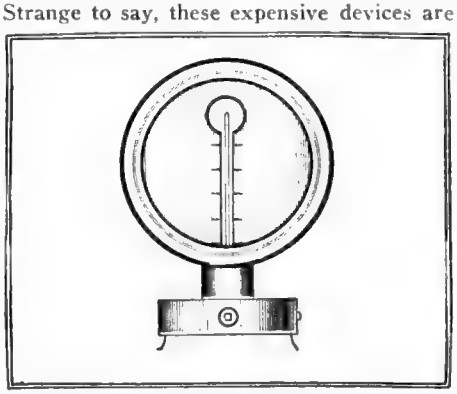
FIRST PRIZE	$25.00
SECOND PRIZE	15.00
THIRD PRIZE	10.00

All other accepted articles, which win no prizes, will be paid for at the rate of $2.00. Articles submitted should not be long ones. About one hundred to two hundred words will suffice. Address all manuscripts to Editor, "Motor Hints," care of this publication.

FOOLING MOTO-METER THIEVES

Third Prize $10.00.

Here is a real kink to those who have had Moto-Meters stolen from their cars. Strange to say, these expensive devices are only screwed on and without protection. There have been many missing in my section lately, which led the writer to look about for a means of securing them, and yet make it handy to remove when water is needed. First the cap part was screwed on tightly to the radiator top, then with a small drill bit and brace a small hole made thru the cap and threads of both parts. Next, a small screw tap was secured and a hole tapt out to take a ½" machine screw. Next, the head of said screw was filed into a little square knob and a hollow key driven over this knob to form a square hole in same, after which this key would serve to unscrew the screw, which held the cap from being turned off by a thief. Any odd screw head will answer because the right tool for taking out this screw isn't in everyone's hand; again a thief taking off one of these devices is not likely to take any extra time getting it off, as they usually take things only that are loose.



Effective Screw Lock for the Moto-Meter.

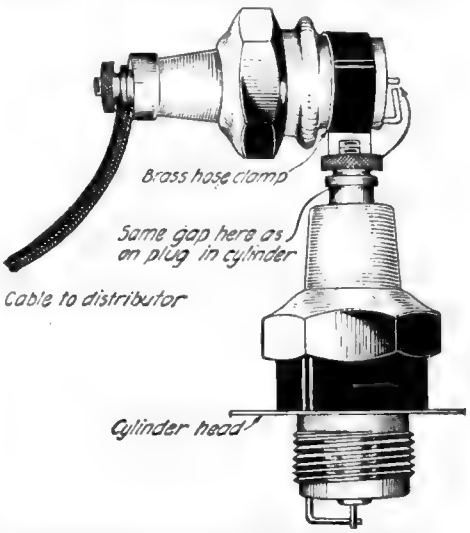
I have had no trouble as yet with this simple protection, while other cars lose meters.

The same trick can be arranged more handy still by having inside the cap a secret spring button, known only to yourself which may be pusht in with a match end, and cap removed when desired.

Contributed by R. C. LEIBE.

INTENSIFYING GAP FROM OLD SPARK PLUG

The high speed gasoline motors of the present day manufacture, very often develop a weak cylinder, due to poor compression or piston rings leaking oil. By intensifying the spark of that cylinder, this undesirable weakness is very readily overcome.



Intensifying Spark Gap Made from a Discarded Plug Fitted on Top of the Usual Plug.

My suggestion is to intensify the spark of that cylinder by means of a gap in the circuit. There are many devices of this type on the market today, sold at fancy prices; but an old spark plug and a brass base clamp are the only things needed for such an arrangement. These may be found in almost any garage or shop.

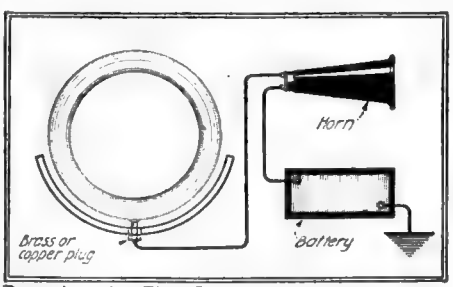
The diagram is self explanatory and I know of numerous instances where this device has worked wonders.

Contributed by JOSEPH A. MAYO.

ELECTRIC FIRE ALARM

A doctor friend of mine was having trouble with his tires, which were continually being stolen, thus losing about eight or nine of them a year. He asked me if I could suggest any way to prevent this trouble, and I made a device to be placed on his car, with which he has already detected several attempts to steal his tires, but the thieves never got very far. The drawing shows how I fixt 'em!

First I run a wire from the battery to the horn; then his auto electric system being grounded, I run another from the tire holder to the horn with an insulated brass plug which is held down by the tires; as soon as a tire is removed, the brass plug rises and makes contact with the frame, causing the horn to blow till another tire is put on. A switch may be connected so as to shut off the alarm when you have no extra tires.



Removing the Tire Causes the Horn to Sound.

Contributed by S. R. SHILLINGFORD.

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Popular Astronomy

By ISABEL M. LEWIS, M.A.

of U. S. Naval Observatory

Measuring the Giants of the Universe

ANOTHER milestone on the road of astronomical progress was reached recently when the diameter of a star was measured by means of the Michelson interferometer, a device destined to rank with the spectroscope and the photo-electric cell in value to the astronomer. As is well known, even the nearest of the stars are so distant that they show no perceptible disks in the most powerful telescopes. The least angle that the great telescopes will resolve is *one-tenth* of a second of arc—the angle subtended by a ten-cent piece viewed at a distance of fifteen miles—and the angular diameters of the giant stars do not exceed two or three *hundredths* of a second of arc, while the average diameter of the nearer stars is scarcely a tenth of this amount, or two or three thousandths of a second.

In *all* telescopes the stars appear simply as points of light. The disc-like appearance of the star images that is to be observed in photographs of the heavens is due simply to the *accumulation of light* upon the photographic plate during the interval of exposure. If we look thru the telescope at these same stars this disc-like appearance vanishes and they appear simply as luminous points.

It can be shown that to resolve an angle of one-hundredth of a second of arc by means of the telescope a lens about forty feet in diameter would be required. Manifestly, then, it is futile to hope to measure the angular diameters of the stars by increasing the size of the lens, since lenses of this size could never be made.

SUN
ORBIT OF MOON
200,000 MILES
MOON
238,000 MILES
EARTH
7900 MILES IN DIAMETER
SUN'S DIAMETER 853,000 MI.
Place 350 of our Suns side by side and they will just reach across the inside of Betelgeuze.

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We Have Been Educated to the Fact That the Earth Is a Rather Small Body. Few People, However, Realize How Exceedingly Small It Is, When for Instance, We Compare It With Our Own Sun. The Above Shows This Graphically. If the Sun Was a Hollow Sphere, You Could Place the Earth in the Center and the Moon Could Still Revolve in the Same Orbit That It Occupies Now. We Would Then Have Almost 200,000 Miles Left Over for Good Measure. In Other Words, the Earth With the Moon and the Latter's Entire Orbit Does Not Even Fill Out the Sun. Still, All in All, Our Sun Is Only a Pigmy As Compared to Betelgeuse.

Fortunately, however, the apparently insurmountable difficulties of the problem can be overcome by making use of the familiar interference fringes found about the focal image of an object by the lens of the telescope. After the light from the object to be observed passes thru the lens the paths of all the rays converging toward the focus are not equal in length. The waves of certain pencils of light interfere with the waves of other pencils so that alternate rings of light and dark are formed about the focal image, if the source is a point, or alternate bands of light and dark, if the light is past thru a slit before striking the lens. If the interference is such that the *crests* of light waves come together a band of maximum light is produced and if the *crest of one wave* and the *trough of another* coincide the result is a ring or band of darkness. The most light falls at the center of the image where pencils equal in length meet and the interference fringes formed by interfering pencils of light are arranged symmetrically with respect to the central image.

Now it has been found that there exists a relationship between the size and shape of the luminous object and the clearness of the interference fringes, and this relationship can be made use of to measure minute angles that can be measured in no other way.

To produce the fringes under the most favorable conditions the light from a star whose diameter is to be measured is first passed thru two parallel slits placed at a definite distance apart in front of the lens of the telescope. Two slits produce fringes that are much finer, sharper and clearer than when only one slit is used. By increasing the distance between the slits the interference fringes can be made to disappear. If the distance is still further increased they will reappear again, then disappear and so on, each successive reappearance being fainter than the preceding one. The first disappearance is the one usually used for measurement. If the distance between the slits is measured at disappearance of the fringes the angle subtended by the object can be found from a simple relationship existing between this angle, the wave-length of light (which can be taken as one fifty-thousandth of an inch) and the distance between the slits.

The interferometer method, as it is called, can be used to measure the diameters of the satellites of Jupiter or of Saturn and of the asteroids and the distance between close double stars as well as the diameter of the stars. An achievement only second in importance to that of measuring the diameter of a star was the measurement of the angular distance between the two components of the close double star Capella, made not long ago by the Michelson interferometer. This angle is of the order of one-tenth of a second and therefore, just at the limit of resolution of the most powerful telescopes.

A valuable feature of the interferometer method of measuring small angles is the fact that its use is not necessarily restricted to the great telescopes.

Some years ago Prof. Michelson obtained by means of an interferometer attached to an eleven-inch telescope at the Lick Observatory measurements of the diameters of the satellites of Jupiter, which average one second in diameter, using slits four inches apart. The results were of the same degree of accuracy as those obtained by long series of direct measurements with the most powerful telescopes. Results as accurate as were obtained with the eleven-inch telescope he considered could have been obtained with a six-inch telescope, since slits placed only four inches apart could be used with a six-inch lens.

The distance between the slits is always in inverse proportion to the diameter of

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the object to be measured, so the smaller the angle to be measured the further apart the slits must be placed, and the distance between the slits is limited only by the size of the object glass of the telescope.

The possibility of the perfection of the interferometer to the point where it would permit of the measurement of angles as small as the angular diameters of the brighter stars when attached to the greatest telescopes in existence was foreseen by Michelson some years ago, and the year 1920 marked the accomplishment of this feat of measurement at the Mt. Wilson Observatory. The giant red variable star Betelgeuse, in the constellation of Orion, has the distinction of being the first star to have its diameter determined by this method.

The angular diameter of Betelgeuse is now known to be approximately three-hundredeths of a second of arc. When the distance of the star from the earth, or its parallax, is also known it is possible to convert this angular diameter into miles and compare the star directly with our own sun. Now the distance of Betelgeuse from the earth is somewhat uncertain, but it is estimated that it cannot be less than one hundred and fifty light years, and it may be twice as great, or three hundred light years. Using the lower limit of its distance from the earth, the diameter of the star comes out as something like three hundred million miles.

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Compare This Picture With the One on the Preceding Page. If the Star Betelgeuse Was a Hollow Sphere, It Could Encompass Comfortably the Sun, the Planet Mercury, Venus, the Earth, As Well As Mars, and There Would Be Still Room to Spare Aplenty for All the Planets to Revolve in, Keeping in Their Present Orbits.

If it is three hundred light years distant from us, its diameter in miles corresponding to the angle measured would be *six* hundred million miles.

We are inclined to think of our own sun as a body of considerable dimensions, at least as compared to the earth and our most familiar standards of measurement. We know that if our planet Earth attended by the moon were placed at the center of the sun, the moon in its orbit would lie about two hundred thousand miles below the solar surface while the earth would be an inconspicuous point at the center of the sun. Now, imagine Betelgeuse to take the place of the sun at the center of the solar system. It would extend nearly *ten million miles beyond the orbit of Mars* and beneath its surface would lie all of the terrestrial planets, Mercury, Venus, Earth and Mars!

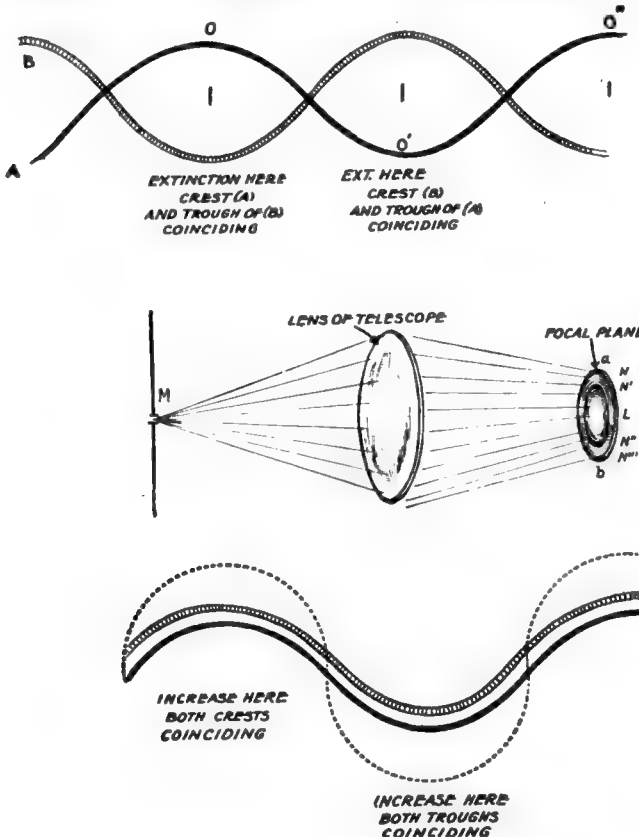
We know that light with its unimaginable velocity of one hundred and eighty-six thousand miles per second would dart seven times around the earth's circumference in *one second*, but it would take nearly *fifty-four hundred seconds*, or about *an hour and a half*, to make the circuit of the mighty globe of this red giant.

It is known that, tho the red giant stars are the bulkiest of all the stars, they also have the least density of all the stars, that is, the quantity of matter in these stars or their mass, in other words, is very small compared to their volume and their gravitational attraction for bodies at their surface is correspondingly weak. The density of some of the red giant stars has been estimated to be as low as *one millionth* of the density of the sun, or about that of the upper strata of the earth's atmosphere. (The density of the sun is one and four-tenths times the density of water.)

Betelgeuse is also an irregularly variable star, as are so many of these red giants of the universe. The cause of its peculiar variability of brightness is still in doubt. It is estimated that the surface temperatures of the red giant stars are comparatively low, probably even less than that of the electric furnace or about 3,000° C., and low enough to permit the formation of certain chemical compounds, a fact which may have some bearing upon its variability of light. It may consist of incandescent, dust-like, particles widely diffused about a central nucleus of greater density. The temperature of our own sun is estimated at something like 6,000° C., while the intensely hot hydrogen stars have temperatures averaging about 10,000° C.

The star Betelgeuse, then, which has become famous as the first star to have its diameter measured by a new scientific device, is a massive red giant, low in temperature and tremendously great in

(Continued on page 1216)



The Central Image L Is Formed by Rays of Equal Length of Path, or Differing by One Wave Length or by Several Integral Wave Lengths. The Same Applies to Bright Circles or to Bright Bands N, M, etc. The Dark Spaces Between Are Formed by Rays Differing in Length of Path by Half Wave Lengths, By One and a Half Wave Lengths, and So On. A Circular Aperture Gives Rings; a Slot-Shaped Aperture Gives Bands. The Diagram Shows Rays (a) Differing by One-Half Wave Length, and Producing a Dark Area or Band; and (b) Differing by One Wave Length and Producing a Light Area or Band.

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Early Steam Engines from Hero of Alexandria to James Watt

By PROF. T. O'CONOR SLOANE, Ph. D., LL. D.

THE fact that when water is heated, steam is produced, thereby producing pressure, has been known for many centuries. The first steam engine is credited to an early mathematician and philosopher, Hero of Alexandria, the date of whose invention is assigned to over a century before the Christian era. We illustrate two constructions of his engine which operated by the action of escaping steam. In the simplest construction, a vessel with tangential outlets is carried by pivots establishing an axis at right angles to the outlets. On heating it, the escaping steam by its reaction effect, causes the vessel to whirl around with great rapidity. In another more advanced construction, one of the bearings becomes a hollow trunnion, admitting steam from a separate boiler, which steam escapes from the outlets, so that no heat is applied directly to the revolving portion.

Little was done beyond this inadequate engine for seventeen centuries. We have already chronicled Leonardo da Vinci's experiment with a cylinder and piston actuated by steam, but this never developed into an engine. A steam fountain was produced by an inventor, de Caus of Heidelberg, in 1615 and Giovanni Branca of Rome in 1629, produced an engine in which an escaping jet of steam blew a sort of paddle wheel around. Then we come to the famous passage in the Marquis of Worcester's book where he tells of his engine, or "water raising" apparatus, and we are informed by the Duke of Tuscany in 1656 that this really did work and was operating in Vaux Hall, London, in 1656. Its construction is not known, but is a matter of probable surmise. The water was lifted 40 feet. Then Thomas Savery in 1698 produced an apparatus for raising water which was probably built on the lines of the Marquis of Worcester's machine, and operated by the alternate production and condensation of steam, and having no moving parts.

The operation of the Marquis of Worcester's engine is problematical, the illustration showing one surmise. By manipulation of the valves the receivers are alternately filled with steam, which is in turn condensed by inflowing water.

About 1711, Thomas Newcomen, a blacksmith of England, a Devonshire man, appeared on the scene. He constructed operative reciprocating engines, with cylinders and pistons, for pumping water from mines. These were beam engines, the pump rod, weighted if necessary, depending from one end of the walking beam and the piston rod depending from the other. The ends of the walking beam were arcs of circles, over which chains passed so as to secure parallel motion for pump rod and piston rod. In its operation, steam was admitted from a boiler placed directly below the cylinder, the steam entering the cylinder below the piston. The combined effect of the weighted pump rod and of the steam, raised the piston to the top of the cylinder. The steam was then condensed. In one construction, a jacketed cylinder was used and water was admitted into the space outside the cylinder and within the jacket to condense the steam. In another construction a jet of water was injected directly into the cylinder below the piston. In either case the condensation by the water was effected after the piston had reached the top of the stroke and the steam had been turned off; this created a reasonably good vacuum below the piston, which descended under the effect of atmospheric pressure. It will be observed that the valves in the Newcomen engine were three in number. The operations were repeated over and over again, and originally the valves were operated by hand. The steam valve had to be opened and shut and the same had to be done with the water inlet valve and the water outlet valve, each at its own proper time. This interesting historic engine ran at from 10 to 16 strokes to the minute. Newcomen made his boilers of copper with lead domes.

A Few April Articles

Shooting Grain, Hardware, Milk and Other Commodities at 200 Miles an Hour Across Country in Electrically Propelled, Air-Driven Trains,—all Automatically operated without motormen or trainmen. The Remarkable Invention of Lester P. Barlow who invented the only successful type of bombs used in the World War, which exploded just before striking the ground—and also the inventor of many other startling and practical war and peace inventions.

Electricity Direct from Coal—Its Possibilities—With numerous illustrations showing apparatus so far developed. By Prof. T. O'Conor Sloane, Ph.D., LL.D.

The Oddities of Physics—Is a Level Line Straight? When is a Plumb Bob Not Plumb?—and many other interesting everyday paradoxes in applied physics, illustrated and described. By H. Winfield Secor.

Monster Animals of Long Ago. With wonderful illustrations. By Dr. E. Bade.

Latest Scientific Developments from the U. S. Bureau of Standards.

Astronomical Photography for the Amateur. Illustrated with photos taken by the author. By H. F. Curtis.

New Science Story, "The Love Machine." By Charles S. Wolfe.

The Sixth Sense. By Joseph H. Kraus.

The Transmission of Power by Waves thru Liquids in Pipes.

The Comparative Losses in the Steam Locomotive Versus the Electric Locomotive.

Radium in Cancer Treatment—With photos and diagrams showing how Radium is applied externally and internally.

In the earlier engines a boy was assigned the job of opening and closing these valves; he was called the "cock boy." The story is told that one of these youths, Humphrey Potter by name, had the ingenuity to tie the valve handles to the moving parts of the engine so as to make it work automatically, which constituted a most important advance. As many as 16 strokes a minute were attained in some of Newcomen's engines.

James Watt's Discoveries

James Watt, born in 1736, and dying in 1819, a Scotchman by birth, was establisht in London as an instrument maker. He received a model of the Newcomen engine from the University of Glasgow to put in order. This was a very small model, but it served to direct his thoughts to the force of steam and he evolved the idea of condensing the steam in a separate vessel, from the cylinder. The effect of this was to maintain the heat of the cylinder, which in the Newcomen operation was cooled by the condensing water with great waste of fuel. This was Watt's great invention which converted the uneconomical Newcomen engine into a machine which at least had within itself the elements for developing economical operation. He also made his engines double-acting. He had endless trouble with the details and the capitalizing of the business of constructing engines. His patent, which is quite a full one, is dated 1769. It is questionable if he would ever had succeeded if it had not been for his association with a capitalist and manufacturer named Boulton. The imperfect Newcomen engine was working in various places, and it was obvious to Boulton that it could be supplanted by the Watt engine. So the firm of Boulton and Watt was formed, and the modern reciprocating double acting condensing steam engine was produced. The first Boulton and Watt date is 1775. Watt invented several methods of converting the circular motion of the walking-beam into a true straight line motion. These devices are termed, rather loosely, parallel motions. One of them is employed in the Watt engine illustrated in our cut. He also invented the ball or centrifugal governor, formerly called the circular pendulum. But the condensing of the steam in a separate vessel, involving the discovery of a new law of thermo-dynamics, is his great achievement.

An interesting retrograde step was the later development of the non-condensing engine, in which Watt's great invention is abandoned. Practically all locomotives are of the non-condensing type. The non-condensing engine is made possible by the use of steam at high pressure.

Such is a resumé of the history of the reciprocating engine. After Watt's time its development was a question of detail.

Of course the story is told of his observing in his boyhood days the force exerted by the steam escaping from the spout of the family kettle. But the repairing of the little model Newcomen engine seems to have been the turning point in his career.

But here a most curious feature in the cycle of invention is to be noted. The first steam engines were reaction engines, Sir Isaac Newton even going so far as to make a little reaction motor car. Then came the engines without moving parts, operating by the alternate pressure and condensation of steam, and then came the reciprocating engine of Newcomen and then of Watt. From the date of Watt to the present, endless efforts have been made to produce the rotary engine, void of reciprocation and operating by direct pressure on a piston following a circular path, and now the most recent type of engine departs from reciprocation and turns its moving member directly by the action of steam, largely on the lines of the old Hero's engine. We allude to the steam turbine. In this construction Newcomen and Watt have been past over and the invention of Hero of Alexandria, 20 centuries old, is in a measure returned to by the modern engineer.

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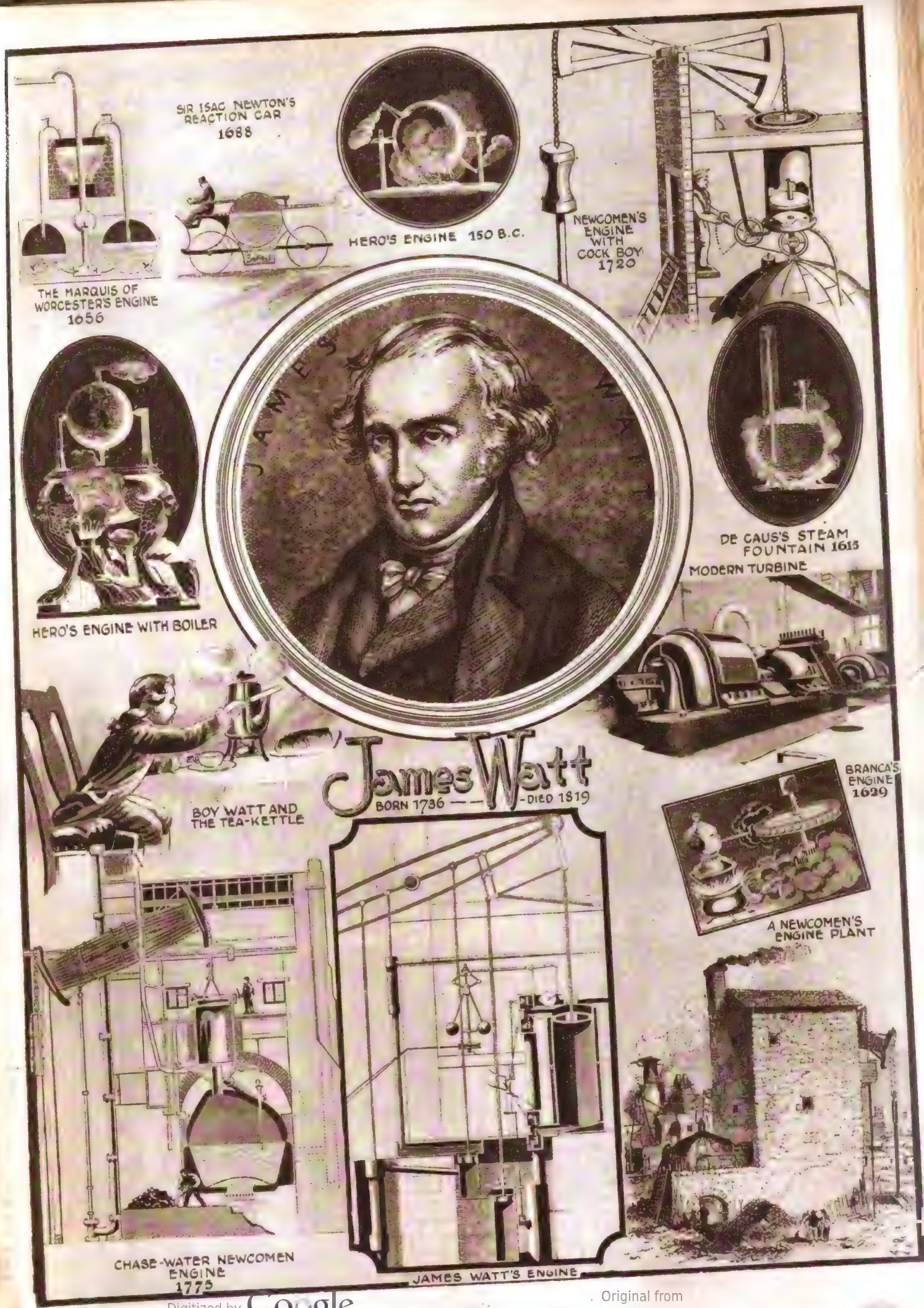
SIR ISAC NEWTON'S REACTION CAR 1688
HERO'S ENGINE 150 B.C.
NEWCOMEN'S ENGINE WITH COCK BOY 1720
THE MARQUIS OF WORCESTER'S ENGINE 1656
JAMES WATT
DE CAUS'S STEAM FOUNTAIN 1615
HERO'S ENGINE WITH BOILER
MODERN TURBINE
James Watt
BORN 1736 — — DIED 1819
BOY WATT AND THE TEA-KETTLE
BRANCA'S ENGINE 1629
A NEWCOMEN'S ENGINE PLANT
CHASE-WATER NEWCOMEN ENGINE 1775
JAMES WATT'S ENGINE

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SCIENCE

Police Stick and Revolver Combined, Form an Excellent Rifle for Long-Distance Emergency Shooting. The Club Is Specially Made, and Accurately Bored and Rifled.

Photo Above Shows New Auto Sign Which Operates in the Same Position As the Usual Hand Signal. It Signals to the Front As Well As to the Rear. It Is Illuminated at Night and the Device Can Be Used As a Parking Lamp, Showing Red to the Rear. It Requires Only a Two Candlepower Lamp.

Photo at Right Shows Latest Type of Aluminum Airplane Built in Germany. The Machine Is Made Entirely of Metal and Has a Wing Spread of About 115 Feet. It Is Propelled by Four 250 H. P. Engines Built Right Into the Wing. Its Capacity Is 18 Passengers.

The Photo Above Shows the Inventor (at Right) and His New Binocular Vision "Movie" Camera Which Is Said to Solve One of the Most Absorbing and Difficult Problems in Motion Picture Work—That of Providing a Picture Having True Depth and Perspective. The Inventor Is P. John Berggren of Swedish Extraction, But Now of Chicago. This Machine Would Seem Then to Give the Effect We Have Long Sought—Real Stereoscopic Motion Pictures in Which the Images Stand Out in Relief.

One of the Latest English Toys Is the Electric Signaling Set Here Shown in Use by Children in a Hospital Ward, Much to Their Delight. The Outfit Comprises a Battery, Signaling Lamps, Etc., Together with a Code Table by Means of Which Messages Can Be Communicated Between Two or More Stations.

A Remarkable New Auto Truck Life and Property Saver. This Automobile Safety Attachment Has Been Designed to Act As a Fender for Picking Up Persons Struck and Also for Preventing a Vehicle from Turning Over Should a Wheel Come Off. The Present Photograph at the Left Shows How a Person Is Saved When Struck by a Truck Fitted with This Device.

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IN PICTURES

A Remarkable Flying Machine Recently Completed by a Chicago Inventor Which Operates Upon the Helicopter Principle. In Other Words, the Machine Lifts Itself from the Ground by Means of Two Sets of Horizontal Blades Which Revolve in Opposite Directions. This Machine Can Rise Vertically and Hover in the Air, Contrary to the Usual Airplane.

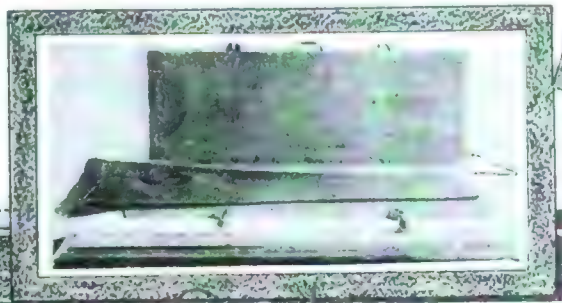
Drop Your Three Cents in the Slot and Out Comes Your Daily Paper. The Only Prerequisite Is That with This Latest Newspaper Vending Machine You Must Have the Proper Change Ready. The Newspapers Are Placed in the Machine the Same As in Chewing-gum Slot Machines with Which Everyone Is Familiar. Three Cents Is Inserted—a Handle Is Pulled—and Out Comes the Paper.

Latest Photograph of the Famous Inventor of the Telephone, Dr. Alexander Graham Bell, Receiving the Freedom of the City, at Edinburgh, Scotland, His Native City, in the Presence of a Distinguished Company. He Is Holding the Handsome Casket Containing the Burgess Scroll. On the Right Is Lord Provost Chosser.

Photo Below Shows the Largest Electric Searchlight in the World and Also Coincidently the Smallest Electric Searchlight, Being Held by the Man Shown at the Left of the Photo. Giant Searchlights Such As the Large One Often Require 50 to 70 Kilowatts to Give Their Full Light Intensity, While the Small One Will Operate on a Few Hundred Watts.

A Marvelous Golf Club. This Club Was Made and Presented to a Prominent Chicagoan by Five of His Friends Who Are Responsible for Its Many Ingenious Features. The Horn and Electric Light for "Night Driving," the Three Shock Absorbers, the Level, the Compass, the Retrievable Ball and Also the Merry Music Box Wound by the Handle Shown at the Rear of the Chassis Are Very Novel in This Unique Club.

Now Comes a French Invention in the Form of a Simple Pants Press, with Electric Heating. The Press Opens Up So As to Permit the Trousers to Be Carefully Laid Out with Recesses for the Pockets. The Press Is Then Closed and Electric Current from the Nearest Socket Applied. After Fifteen Minutes the Trousers Are Ready to Be Taken Out. ©Keystone.



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The Devil's Understudy

By CHARLES S. WOLFE

OUR readers will be very much interested in this story which contains considerable food for thought. In our March, 1920, issue we described a patented apparatus by whose means electrical currents are carried by ultra-violet rays, which latter act as conductors. This makes Mr. Wolfe's story very plausible, and we hope our readers will enjoy Mr. Wolfe's latest efforts.—Editor.

MOST every town's got one, I guess. Crazy scientist, I mean. One of these absent-minded, high-browed old birds that comes wandering trance-like down the street with their hands behind their backs and their minds off some place in "The Sweet Bye and Bye." People turn and grin when one of them passes and says to one another, "There goes that crazy scientist."

I don't. Grin after 'em, I mean. I turns and gives them birds the most careful double O. I notes any little peculiarities, now—their gait, height and so forth. And if I ain't got too much else to do just then, I tags along after them, casual-like, and see where they hang out. Then if I want 'em again I know where to start and look. 'Cause you never can tell about those babies.

Nine out of ten of them is just mild nuts; the kind that gets in the bathtub and forgets to turn the water off. But the tenth lad! Oh, boy!,

The saw-bones that examined Gleason told me that insanity is merely a question of degree. Which, I take it, is just saying that some is bad and some is worse. Gleason, now, was in a class by himself. Hands down, he wins the non-skid soap dish. Twenty years I've been roaming the streets in plain clothes, and I've only run into one Gleason. If ever I meet another I'm thru roamin'.

"* * * All Three of Us Has Had Considerable Experience in These Matters, and It Only Takes a Minute for Us to See That He's Been Gathered to His Fathers. Sure Enough. But the Funny Part of It Is, That We Can't See No Trace of What Took Him Off. No Bruises, Wounds or Anything. And You Simply Can't Croak a Guy Without Doing Something to Him."

Remember the Gleason case, do you? I'll never forget the way it started off. I was in the office with the old man, makin' a report, when Bill Lawrence comes bustin' in without even knocking. His eyes were bulging right out of their sockets and you could see something had upset him awful.

The Old Man gets ready to freeze Bill for his sudden entrance, but Bill never gives him the chance. "For Gawd's sake, Chief," he cries, "it's terrible! Horrible! I——"

"Heavens, Lawrence," yells the Chief, mad as a wet hen. "Are you growing hysterical? What's terrible?"

"Murder!" gasps Bill, wildly.

"Well, what of it?" roars the Old Man. "Haven't you ever seen murder before? What's the matter? Losin' your nerve?"

"Yes, but these murders——" Lawrence protests, feebly.

"These murders?" echoes the Chief. "There was two of them, then?"

"Ten of 'em, Chief," Lawrence half sobs.

"Ten of them?" bellows the Chief. "That ain't murder, you boob, that's civil war. What are you talking about?"

"It's true, Chief," says Lawrence, solemnly, getting some kind of a grip on himself. "Ten men killed right out on the open street and pobody knows who done it or how it was done. Big fellows, they are, too; bankers and the like."

The Chief was getting right down to business. "Bomb outrage, was it?" he growls at Lawrence.

"No, sir," replies Bill. "No violence, sir."

"No violence?" the Old Man bleats. "What's eatin' you, Bill Lawrence? How can you have murder without violence? A gink is shot, stabbed, strangled, poisoned or beaten. If you don't think them's violent just ask the victim. How was this job pulled off?"

"I don't know," says Bill, soberly. "I looked the bodies over. No marks on them. Not one. They're just dead, that's all. They topple right over in the street, right in a crowd. They don't even holler. When you pick 'em up they're deader 'n Rameses."

"Humph!" growls the Chief. "Something wrong, somewhere. I——"

(Continued on page 1233)

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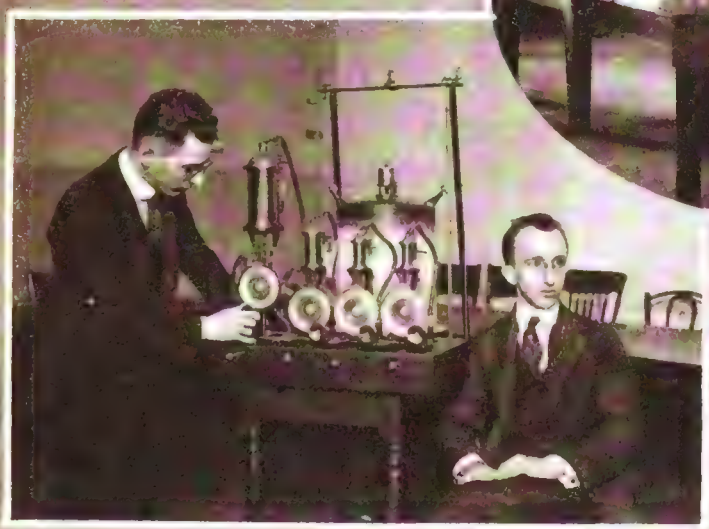
How is Your Mental Balance?

Psychological Examinations Being Made at Columbia University, New York City, to Test the Mentality and Efficiency of Men and Women. The Illustration at the Right Shows the "Color" Perimeter Which is Used to Measure the Field of Vision and the Color Zones of the Retina of the Human Eye. By Means of the Graduated Dials These Factors May Be Measured to a Fraction of a Degree.

Another View of the Psychological Testing Laboratory at Columbia University. Here the Subject is Placed on a Pivoted Table Fitted with a Scale and Balance Weight and the Various Mental Sensations Produced in the Subject's Mind Are Noted Thru Many Changes. This Practical Test Is Carried Out for Determining the Various Labyrinthine Sensations.

Illustration at Right Shows a Subject Blindfolded and Placed on a Revolving Chair, the Same as Used so Successfully in Testing the Balance in Selecting Aviators During the War. This is Known as the "Orientation" Test. The Subject is Revolved and Tries to Tell at What Point He Stops Each Time. A Graduated Dial is Placed Under the Revolving Stool with a Pointer Attached to the Stool as Shown.

At Right: Metronome and Electro-Mechanical Apparatus Used in Columbia University Psychological Laboratory for Measuring the Degree of Fatigue, by Means of the Masso-Ergograph. By Means of This Instrument the Man's Muscular and Nervous Endurance Is Accurately Measured in Minutes and Fractions of a Minute.



Picture at Left Shows Subject Seated and Endeavoring to Determine by the Sense of Hearing the Change in Tones as Created by the Expert at the Extreme Left, Who Is Seen Manipulating the Apparatus for Generating Different Musical Tones. This Apparatus Is What Is Known as the "Stern's Tone Variator." The Various Tones of the Musical Scale Are Created by a Blast of Compreat Air Shot Thru Openings in a Revolving Disc Having a Definite Number of Holes in Its Perifery and Constituting a Siren.

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Dr. Pringle Discusses Mind

By JOHN H. DEQUER

"MIND and life are so closely related that we cannot really consider one apart from the other," said Doctor Pringle as he touched the tendrils of a sensitive plant with a small brass rod. "They are different aspects of that peculiar, etheric transformation we call vitality."

As we were seated in his country laboratory watching the marine life in his large salt water aquarium, my attention was drawn to the antics of a fish which moved back and forth with almost clock-like regularity, while the rest of the living things seemed to move at random as if actuated only by choice.

Noticing my preoccupation and anticipating the question in my mind, Doctor Pringle remarked, "Every movement of living things is the result of some force at work upon their nervous or protoplasmic structure. If we knew what these forces were and could accurately measure and calculate their rates and intensities, then we could predict every movement of fin, and every flop of tail in these creatures as well as all the brain processes of man, for we can rest assured that there are no causeless and therefore no reasonless processes in nature.

"These little animals wiggle and swim as they must; under the forces at play upon their tissues, they cannot wiggle or swim otherwise. All acts, whether of an amoeba or a Tesla are the result of an interplay of the subatomic forces as yet not understood upon the cell structures of living things. To determine what these forces are, and if possible to control them to our advantage is one of the great problems of science."

"But how would you proceed to discover these forces?" I asked with no little curiosity.

"I am on their trail now," he answered. "This pool which you see thru the glass in the laboratory wall is my first milestone. In it I study the lowest forms of life under natural conditions, for it is in the lowest forms that we find the least complexity and therefore they are the logical structures with which to begin. Life is life. It is the same in the amoeba as in the elephant. In fact an elephant is but an amoeba infinitely multiplied. A man is but an amoeba infinitely complexed. To understand the uni-cell is the first step in our study of the multi-cells, as we may call the higher animals.

"The pool itself is quite an idea," he went on with just a little note of pride in his voice. "It is formed from a natural hollow in the top of this granite cliff. I have built the cottage so that thru this heavy plate glass window in the basement wall I can see what goes on in the water from the surface down for ten feet. The pool has a sloping beach on the west side. On this slope I have fastened several glass devices for arresting these forms of life, which habitually frequent certain depths. I have discovered that these creatures act differently under different conditions of water pressure, electric, magnetic and radiant energy.

"In the ravine, a little to the north of the pool, is a creek which tumbles from the highlands into the sea over a series of rocky ledges, and here I have installed a water turbine which supplies electric energy, not only for the needs of the ranch, but by means of a mechanical device anchored in a little inlet from the sea, I regulate a centrifugal pump so as to keep time with the tide; thus I produce actual tidal conditions in my pool.

"I need this kind of an arrangement if I am ever to understand how in the primordial ages the uni-cell became worm, the worm fish, the fish reptile, the reptile mammal, and then came man. All life came up out of the sea. And sometimes life goes back to her, as it did in the case of the whale and the seal.

"You see, during the primitive ages of this world's history the continents first heaved up from the warm bosom of the

(*Continued on page* 1251)

"I Need This Kind of An Arrangement If I Am Ever to Understand How in the Primordial Ages the Uni-Cell Became Worm, the Worm Fish, the Fish Reptile, the Reptile Mammal, Developing Into Man. All Life Came up Out of the Sea. And Sometimes Life Goes Back to Her, as It Did in the Case of the Whale and the Seal."

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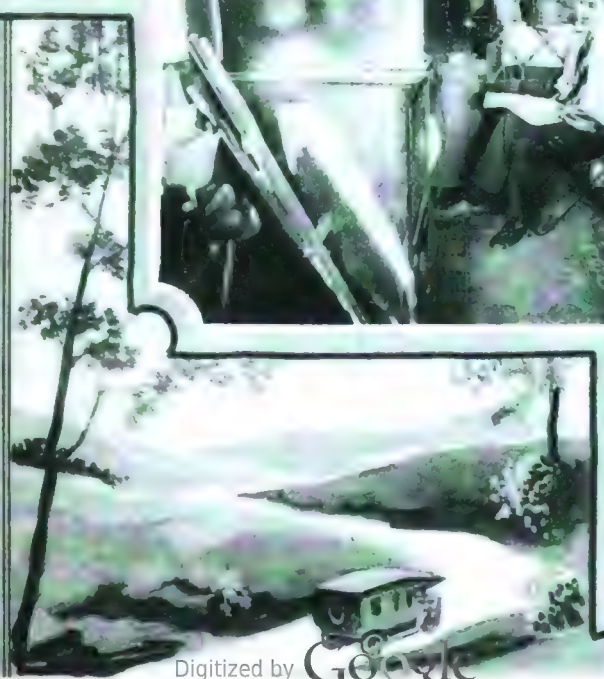
"At Home" in an Auto

"HOME was never like this!" Mr. and Mrs. Robins who have built a complete little traveling home of their own, are shown in the accompanying photograph. They even have a name for their home on wheels—"The Adventurer,"—and besides they eliminate the worry of the empty coal bin, not to mention the gas man, the water meter bill and several dozen other petty annoyances of everyday life. They have no landlord to take the cheer out of the end of each month.

This automobile home is built on a regular truck chassis and includes a bedroom, living room, dining room and printing shop. It is thus an easy matter for the lady of the house to watch the cooking and prepare the potatoes at the same time that the phonograph reels off the latest jazz tune. Other advantages are to be found by the dozen. Suppose one fine October morning you awoke and found the air quite chilly—instead of taking out the wool underwear from the moth balls in the trunk and ordering about 10 to 15 tons of coal at $20.00 per ton—you walk around the corner, to the nearest map shop and buy a few road maps covering the complete route to the sunny southland—where the orange blossoms bloom and the oriole sings sweetly all day long.

Mr. Robins combines business with pleasure and finds no difficulty in getting orders in the various towns and cities for printing, which helps to pay the gasoline and tire bill. Mr. and Mrs. Robins and their pet bull dog have visited nearly every state in the Union.



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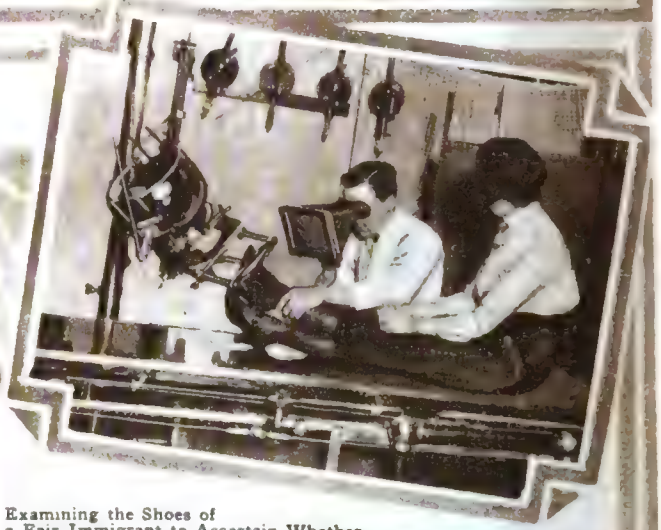
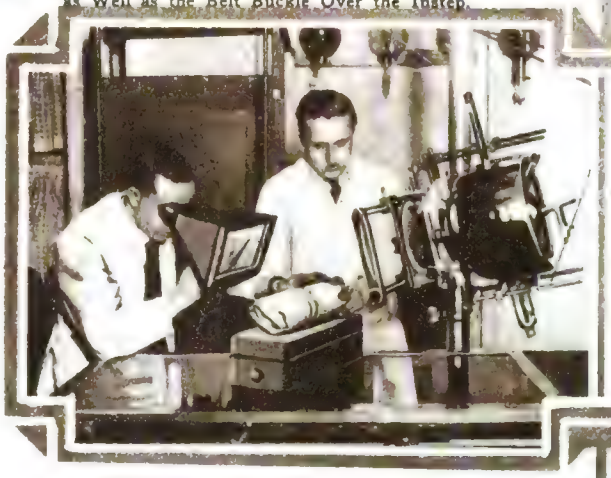
ODD USES FOR X-RAYS

It is a Great Surprise, But Here is What the Innocent Looking Little Lady Had Concealed in Her Shoe,—Two Undeclared Diamond Rings, Possibly Worth Several Thousand Dollars. Note the Wonderful Detail in This Skiagraph of the Foot and Shoe, the Steel Arch and Shoe Nails Showing Clearly, as Well as the Belt Buckle Over the Instep.

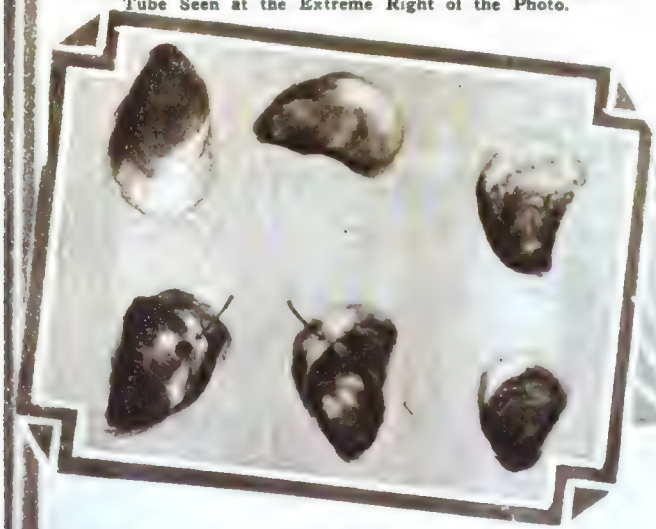


Examining the Shoes of a Fair Immigrant to Ascertain Whether or Not She Happens to Have Any Jewelry or Other Undeclared Valuables Secreted in a Hole in the Heel, or in a False Sole, Perhaps. The Operation is Quickly Carried Out and Without the Slightest Inconvenience.

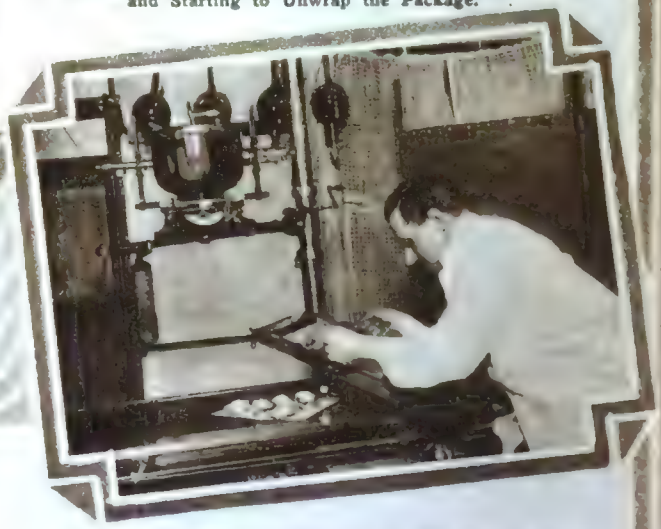


In the Custom House and Police Inspection Depots, the X-ray Makes It a Sinecure to at Once Ascertain Just What is in Any Suspicious Looking Package Such as the One Which is Being Held Between the Fluoroscope and the X-ray Tube Seen at the Extreme Right of the Photo.

The Suspicion Confirmed!—a Bomb! Imagine What Havoc This Fiendish Invention Might Have Wrought, if it had Reached Its Destination, and the Recipient Had Opened It in the Manner Intended—That is by Cutting the String and Starting to Unwrap the Package.



And Here We See What the X-ray Discloses When an Oyster Contains a Pearl or an Embryo Pearl, That is, One in the Early Stages of Growth. The Black Spot Indicated by the Arrow Represents a Fully Grown Pearl and the Light Spot a Partially Grown Pearl. Oysters Containing a Partially Grown Pearl Are Cultivated and Watched Until the Pearl Grows to Maturity.



Giving the Pearl-Bearing Oyster the Third Degree Under the X-ray. Previously Many Thousands of Oysters Were Opened Annually by Fishermen and Others in a Ruthless Attempt to See If They Contained Any Pearls. Now, Thanks to the X-ray This Examination Has Become an Exact Science and the Oyster is Not Harmed in the Least.

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Science Kinks

Here Is a Storage Battery Steam Table and Work Bench Which Does the Work on One Table Which Formerly Required Two, Three or Four. It Drills the Posts of the Battery, Steams It Thru the Steamer at the Side, and a Lifting Vise Also Lifts Out the Elements to Be Repaired.—Photo From American Bureau of Engineering.

If You Are a Bachelor, Why Not Press Your Ties the Electrical Way? Moisten Them Slightly and Simply Rub Them or Pull Them Over an Electric Light Bulb.

An Alarm Clock Rigged Up with a Spool, Some Cord and a Hasp or Bolt on the Door, Provides Us with an Automatic Door Opener to Admit the Maid in the Early Morning.

If You Want to Copy a Drawing, Try This Scheme of the "Reflecting Drawing Board." Place the Drawing Next to a Sheet of Glass Mounted in a Frame, and on the Opposite Side of the Glass Place a Plain Sheet of Paper. Looking Thru the Glass You Will See the Image Clearly on the Plain Paper — Then Proceed to Trace the Lines Over the Reflected Image.

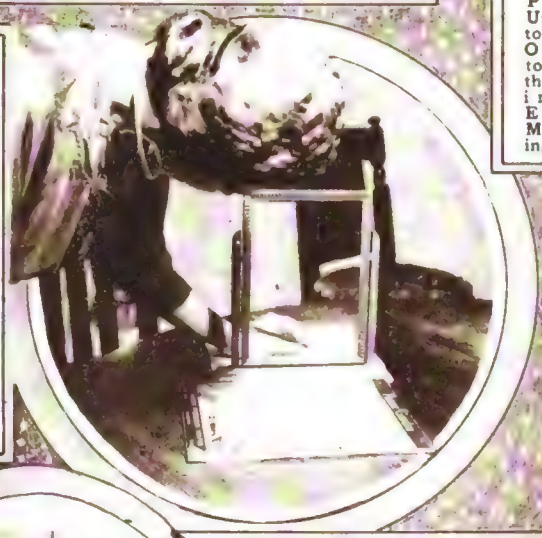

Photo at Left Shows the Latest Wrinkle in a Liquid Soap Container Which Is Arranged to Hang from a Chain in the Shower Bathroom. The Nickeled Dispenser Contains Liquid Soap Which Is Expelled Whenever the Container Is Shaken. This Is a Decided Improvement Over the Old "Catch-As-Catch-Can" Battle with the Elusive Cake of Ivory.

Another Useful Science Wrinkle Applicable to Home Needs. This Consists in Placing an Electric Light Bulb in the Oven Which Provides Just the Right Amount of Heat for Bread Raising. A 60-Watt Bulb Will Usually Provide the Proper Amount of Heat, But This Will Depend Somewhat Upon the Size of the Oven.

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"Fathoms Deep" A Subsea Movie Thriller

The Most Spectacular Picture Which Will Soon Be Brought to the Attention of the Motion Picture Audiences Is the One Produced by J. E. Williamson, Who, with the Aid of the Apparatus Invented by His Father, Capt. C. Williamson, Has Been Able to Show Exploits Not Only on Land and in the Air, but Actually Fifty Feet Under the Water.

The Story Is of a Riff-raff Crew Running Amuck in and About the Tropics With a Stolen Submarine. The Band Having Turned Pirates Are Waylaying and Looting All Passing Craft and Hiding Their Spoils. A Love Story Is Intermingled With the Plot and a Series of Conflicts on the Surface of the Sea as Well as Along Its Bottom Between Two Rival Treasure Expeditions, Both Equipt With Diving Suits and Helmets, Is One of the Many Startling Novelties in Dramatic Surprises Presented in This Pretentious Work. Eleven Months Have Been Spent in Taking the Picture, Ralph Ince Himself Directing and Playing One of the Leading Rôles in Association With Film Favorites.—Photos Courtesy J. E. Williamson.

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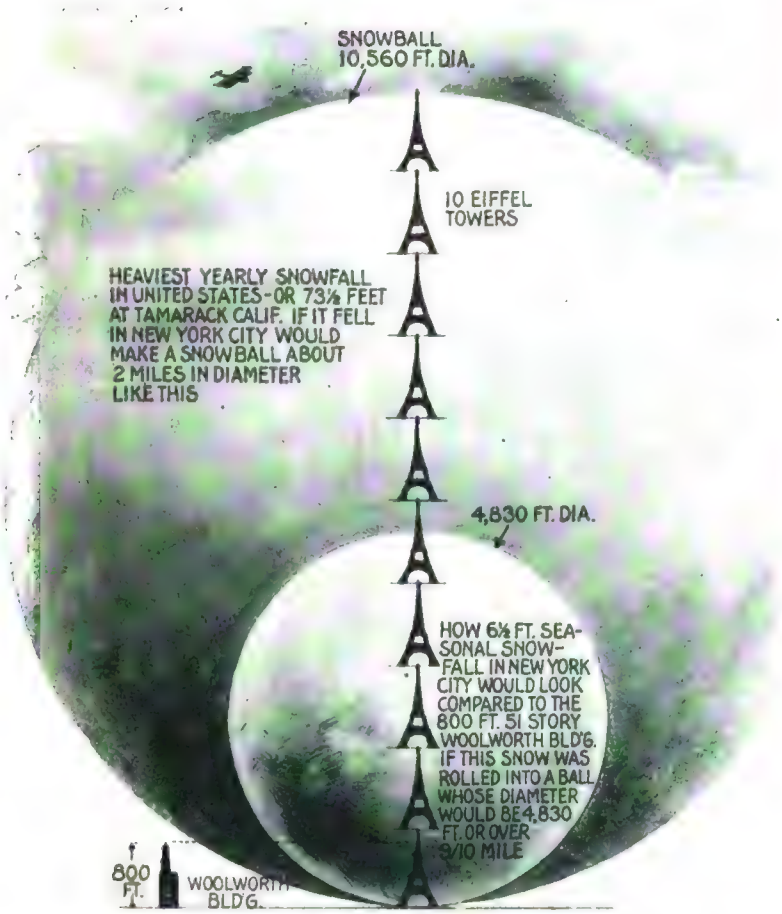
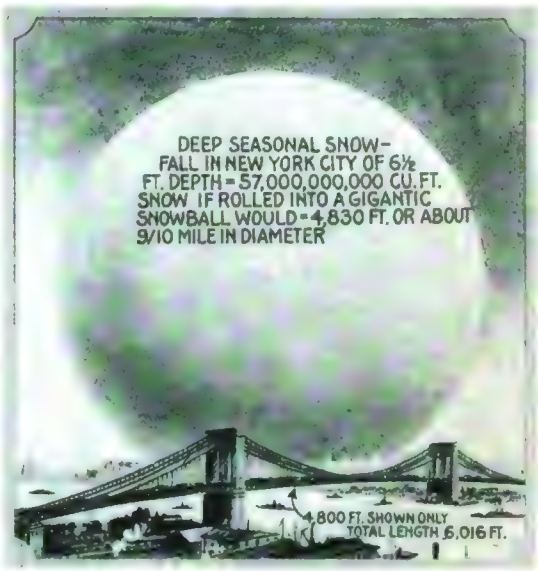
If New York City Were the Snowiest Place

By CHARLES NEVERS HOLMES




DEEP SEASONAL SNOW-
FALL IN NEW YORK CITY OF 6½
FT. DEPTH = 57,000,000,000 CU. FT.
SNOW IF ROLLED INTO A GIGANTIC
SNOWBALL WOULD = 4,830 FT. OR ABOUT
9/10 MILE IN DIAMETER
4,800 FT. SHOWN ONLY
TOTAL LENGTH 6,016 FT.

The Accompanying Illustration Shows Vividly What a Giant Snowball All the Snow Falling During One Winter in New York City Would Make, As Compared to the Brooklyn Bridge. This Snowball Was Computed for a Typical Deep Snow Fall of 6½ Feet for the Entire Winter.

A Typical New York Seasonal Snowfall Rolled Into a Giant Ball Nearly One Mile in Diameter Is Shown at the Left, Compared to a Still Greater Snowfall of 73½ Feet, the Record Fall Which Occurred at Tamarack, Calif. This Gigantic Snowfall, If It Fell in New York City and If Rolled Into a Single Large Ball, Would Have a Diameter As High As Ten "Eiffel Towers," or More Than 10,000 Feet.

THE average annual snowfall in the State of New York amounts to about 7 feet, and there is a record of a snowstorm in New England, which lasted from the 19th to the 24th day of February, 1717, when the snow fell to a depth of 5 to 6 feet. Almost every part of the United States, including Florida, has had some sort of a snowstorm during the past century, and our "Weather Bureau" announces that the heaviest snowfall in this country takes place on the Pacific Coast. That is, the heaviest snowfalls occur in the Cascade mountains of Washington and Oregon and in the Sierra Nevada mountains of California. In this region, during the winter season, the snow accumulates upon level ground to *a depth of 25 to 30 feet*, being twice as deep as that in the canyons and gulches. Indeed, in the higher parts of the Sierra Nevada mountains an average *snowfall of 65 feet* is not unusual. And, at Tamarack, California, about a mile and one-half above sea-level, there was a record of *a snowfall of 73½ feet which fell during* the winter of 1906-1907.

Now, a snowfall of 73½ feet, or 882 inches, is certainly considerable snow and, in all probability, Tamarack, California, is the most snowy place in the United States. And such a snowfall, when melted, would amount to a good deal of water, an average of over 7 feet of water, inasmuch as, under ordinary conditions, 10 inches of snow yield 1 inch of water. Therefore, the amount of "frozen vapor" falling in Tamarack, as thus recorded, would be equal in depth if it were melted to water, to about the unmelted average annual snowfall in the State of New York. And such a vast snowfall descending upon a square mile of surface would approximate 2 billion cubic feet. Accordingly, were 73½ feet of snow to fall during the winter of 1920-1921 upon the City of New York, provided none of it melted or was removed, that city would be buried beneath 645 billion cubic feet of snow. Then, were all this snow to melt suddenly, New York City would be inundated by 65 billion cubic feet of water. If all of that 73½ feet of snow which covered the whole city were to drift up wholly upon Central Park, that park would be "snow-bound" to a height of about 3 1/3 miles. Such a huge seasonal snowfall of 73½ feet should be compared with an unusually deep seasonal snowfall in New York City of about 6½ feet. This latter snowfall would cover New York City with approximately only 57 billion cubic feet of snow.

Alcohol from Petroleum

ANNOUNCEMENT of the discovery of a new alcohol closely akin to wood and grain alcohol in its adaptability to commercial purposes was made by the Standard Oil Company at the same time that Carleton Ellis, who developed the process, announced in Newark to the New Jersey Chemical Society, of which he is President, that it had at last become possible to make the new alcohol, or *petrohol*, as it is called, from the by-products of petroleum refining.

On behalf of the Standard Oil Company, which has the rights thruout the world to manufacture the new product, Frank D. Howard, in charge of the Corporation's Development Department, made the announcement that petrohol was being made for commercial purposes at the Company's Bay Way Refinery at Elizabeth, N. J., Mr. Howard explained that while a small quantity of petrohol, if taken internally, might not produce the deadly effects of wood alcohol, it nevertheless was inherently a poison, and could not be used as a beverage.

At the Bay Way Refinery it is being manufactured at the rate of about 250 gallons a day, according to Mr. Howard, who explained that it was intended for use chiefly in the arts, as a solvent of gums, rosins, shellac, etc., and may be used as a substitute for wood and grain alcohols, because it is somewhat cheaper than the latter. He suggested that petrohol also might be destined to play a great part in the development of the dye industry of America, for it is possible to manufacture it in practically unlimited quantity.

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Fig. 1 — Top Photo Shows Giant Cameras and Arc Lights Used in Photographing the Pictures to Be Printed in "Rotogravure."

Fig. 2—Intensifying the Lines and Shadows on the Photographic Negatives.

Fig. 3 — Printing the "Form" Containing the Films Mounted on Glass; the Image Is Being Transferred by Powerful Electric Arc Lights to Carbon Printing Paper. This Printing Is Done in a Vacuum Frame Which Causes the Paper to Be Held Very Tightly Against the Films.

Fig. 4—Copper-Plating Steel Cylinders in the Electro-Plating Room, the Dynamo Supplying the Current for the Process Appearing at the Left. The Copper Is Deposited on the Cylinders Electrolytically.

Fig. 5—When a Sufficient Thickness of Copper Has Been Deposited on the Steel Rolls They Are Accurately Turned, Ground and Finally Polished. They Must Have a True and Even Diameter Along Their Entire Length.

Fig. 6—The Pictures from the "Form" Have Been Transferred to the Copper Cylinder by Wetting the Carbon Tissue Containing the Images and Wrapping It Around the Cylinder. The Images Are Now Ready for "Etching" with Acid, As Shown Above.

Fig. 7—Here We See the Final Stage, "Rotogravure" Pictures Being Printed from Roll Paper Passing Rapidly Over the Copper Cylinders Containing the Images; This Press Cuts and Folds the Finished Sheets.

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How Rotogravure Pictures Are Made

By OSWALD R. SCHULTZ*

SINCE almost all the Sunday newspapers and many magazines thruout the country have either supplements or inserts printed by the *rotogravure* process, the description of how this is done will be of interest to the readers of this journal. It is the latest and most valuable application of photography to the printing press, so far as artistic results are concerned, and by it a web of paper can be printed from a copper cylinder at high speed.

The following article will give, we hope, a description of the process in a popular and simple manner.

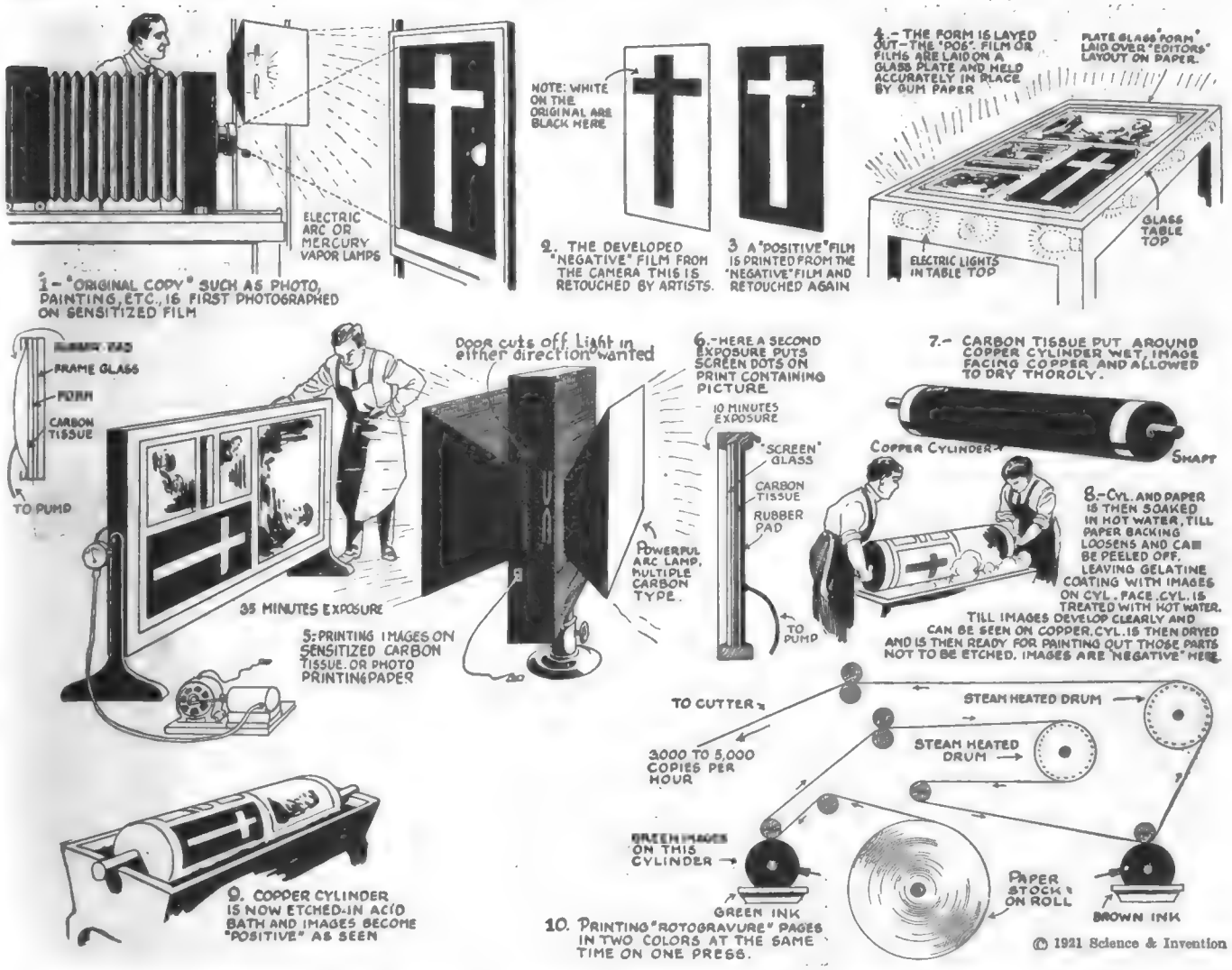
One of the interesting developments of this rotogravure studio is a giant camera, probably one of the largest in the world. On seeing this camera you would not recognize it as such, unless its mysteries were explained to you. This camera, unlike the usual type with which we are all familiar, has no bellows at all. Instead, these are substituted by a large room which has been finished with a dead black paint and a huge plate and film holder slides along on a bed or table so as to be readily focused. In the front wall of the room a hole has been cut about one foot square and in

"Making Up the Form"

By pasting the retouched positives on a large piece of plate glass, we enter the second stage of the process, which is called "making up the form." A large piece of plate glass is placed on top of a ruled layout and each positive placed in its marked place on this glass.

The form is then ready to be taken into the carbon printing room, where it is placed in a *vacuum printing frame.*

In the meantime carbon tissue paper, which comes in rolls 3 by 12 feet and which consists of a strong paper evenly


ELECTRIC ARC OR MERCURY VAPOR LAMPS
1- "ORIGINAL COPY" SUCH AS PHOTO, PAINTING, ETC., IS FIRST PHOTOGRAPHED ON SENSITIZED FILM
NOTE: WHITE ON THE ORIGINAL ARE BLACK HERE
2. THE DEVELOPED "NEGATIVE" FILM FROM THE CAMERA THIS IS RETOUCHED BY ARTISTS.
3 A "POSITIVE" FILM IS PRINTED FROM THE "NEGATIVE" FILM AND RETOUCHED AGAIN
4.- THE FORM IS LAYED OUT- THE "DOG" FILM OR FILMS ARE LAID ON A GLASS PLATE AND HELD ACCURATELY IN PLACE BY GUM PAPER
PLATE GLASS "FORM" LAID OVER "EDITORS" LAYOUT ON PAPER.
GLASS TABLE TOP
ELECTRIC LIGHTS IN TABLE TOP
FRAME GLASS
FORM
CARBON TISSUE
TO PUMP
DOOR CUTS OFF LIGHT IN EITHER DIRECTION WANTED
35 MINUTES EXPOSURE
5: PRINTING IMAGES ON SENSITIZED CARBON TISSUE. OR PHOTO PRINTING PAPER
POWERFUL ARC LAMP, MULTIPLE CARBON TYPE.
6.- HERE A SECOND EXPOSURE PUTS SCREEN DOTS ON PRINT CONTAINING PICTURE.
10 MINUTES EXPOSURE
"SCREEN" GLASS
CARBON TISSUE
RUBBER PAD
TO PUMP
7.- CARBON TISSUE PUT AROUND COPPER CYLINDER WET, IMAGE FACING COPPER AND ALLOWED TO DRY THOROLY.
COPPER CYLINDER
SHAFT
8.- CYL. AND PAPER IS THEN SOAKED IN HOT WATER, TILL PAPER BACKING LOOSENS AND CAN BE PEELED OFF, LEAVING GELATINE COATING WITH IMAGES ON CYL. FACE. CYL. IS TREATED WITH HOT WATER. TILL IMAGES DEVELOP CLEARLY AND CAN BE SEEN ON COPPER. CYL. IS THEN DRYED AND IS THEN READY FOR PAINTING OUT THOSE PARTS NOT TO BE ETCHED. IMAGES ARE "NEGATIVE" HERE.
9. COPPER CYLINDER IS NOW ETCHED-IN ACID BATH AND IMAGES BECOME "POSITIVE" AS SEEN
TO CUTTER
3000 TO 5,000 COPIES PER HOUR
STEAM HEATED DRUM
STEAM HEATED DRUM
GREEN IMAGES ON THIS CYLINDER
GREEN INK
PAPER STOCK ON ROLL
BROWN INK
10. PRINTING "ROTOGRAVURE" PAGES IN TWO COLORS AT THE SAME TIME ON ONE PRESS.
© 1921 Science & Invention

Illustrating the Successive Stages Followed in Reproducing Photos and Text Matter by Famous "Rotogravure" Process.

Photographing the Original Subject

The first stage of the process is the making of the photographic film negative from the original drawing or photograph. (Fig. 1). This negative is made as crisp and clear as possible as upon its success depends the quality of the *positive* made from it, and the success of the subsequent operations. Great care is taken in retouching the negative as well as the positive. (Fig. 2). This consists not only in adding shades to the negative by working over the varnished or ground film with soft lead pencils but in removing shades by scraping with a sharp knife on the positive.

this the lens is fitted. This panel may be quickly released and different lenses inserted to suit the work in hand. Outside the room and directly in front of the lens there is a second bed or rack on which the copy carrier slides, this carrier comprising a large vertical frame or panel on which the art work (photograph, painting, etc.) can be secured. This giant camera is of course, only used for larger layouts and art work of unusual size. The focal capacity of this camera is eight feet, and the largest plate or film which can be accommodated, is sixty inches by thirty-five inches. For photographing the usual size of photos and other illustrations, the standard photo-engravers' type of copying camera is employed.

coated with gelatin containing a brown pigment is sensitized in bichromate of potash squeegeed on a ferrotype plate and dried for not over two hours.

Printing the Pictures on "Carbon Tissue"

When ready to be used the carbon tissue is cut into proper size and placed on top of the form in the vacuum printing frame. The vacuum printing frame is in a small way the same kind of frame that is used by amateur photographers to print their Kodak pictures, only in an enlarged form. The small sized frame gives the necessary contact by a steel spring while the large sized frames have a more elaborate mech-

(*Continued on page* 1220)

*Of the Neo-Gravure Printing Co., who print the Rotogravure Section of this journal.

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Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

The Velocity of Light

By PROF. JAMES S. STEVENS

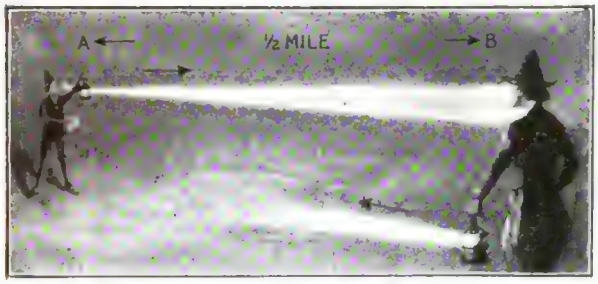

Fig. 1. Early Measurement of Velocity of Light. The Time Required to Flash a Light From A to B and Return or One Mile, Was Found to Be 1/186,000 Second.

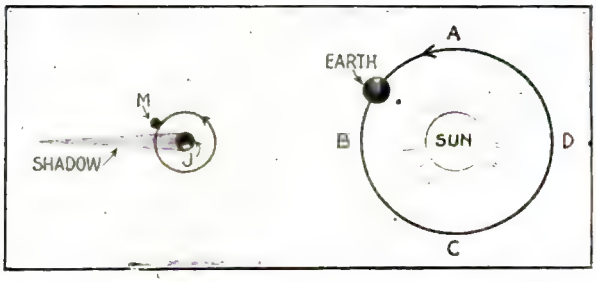

Fig. 2. Measuring Velocity of Light by the Eclipse of Jupiter's Moon.

BEFORE the time of Galileo those who paid any attention to the subject at all were probably of the opinion that the instant light left the sun it reached the eye of an observer upon the earth. Galileo will be taken as a type of the experimental physicist so long as the science endures. Not content with accepting this dictum of the ancients he undertook to measure the *velocity of light*.

He suggested that if two observers were stationed at a certain distance apart and each provided with a dark lantern, then if one observer should flash his lantern and the second observer should give a similar signal when the light was received, the interval between the two signals would be the time of the round trip made by the light. See Fig. 1. If we assume that these observers were one-half mile apart the time occupied for the light to pass from the first observer to the second and back again is known to be about 1/186,000 second. Inasmuch as their best recording instruments were unable to measure time intervals accurately to the tenth of a second it is obvious that this experiment must have been a failure. The credit of the suggestion, however, belongs to Galileo.

About the year 1685 Roemer, a Danish astronomer, noticed that the time of an eclipse of one of Jupiter's moons was nearly one thousand seconds behind the schedule when the earth was on the opposite side of the sun from Jupiter. Dividing the double distance from the earth to the sun by one thousand ives us approximately a correct value for the velocity of light. See Fig. 2. Roemer's problem was a very difficult one and we have given only the barest outline. Very accurate results for the velocity of light were obtained by two Frenchmen—Fizeau and Foucault, about 1850. Fizeau used a revolving toothed wheel and Foucault a revolving mirror, which was later modified and improved by two Americans, Michelson and Newcomb, who made the standard determination of this constant.

The value of the velocity of light is an extremely important magnitude in physics. There are three reasons for this:

1. It is used as the celestial yard stick.
2. It has an important bearing upon the nature of light.
3. Recent developments have given it an increased importance in connection with the modern theory of relativity.

When an astronomer wishes to measure distances in the heavens he finds the numbers of such extraordinary magnitude that our ordinary units are not comparable with them. It is, of course, necessary that the unit of measurement should be comparable with the thing measured. We would not, for example, think of measuring the length of a room with a scale one centimeter long; nor would we attempt to measure the thickness of a coin with a scale graduated in inches only. When we express the distance from the earth of one of our nearest sidereal neighbors, *Alpha Centauri*, a star in the southern heavens, we have to use the number 2.6 (nearly) with 13 ciphers attached, if our unit is the mile. Astronomers, therefore, are accustomed to express these enormous distances in what is known as the light-year. One light-year represents the distance which light travels in one year and is found by taking the product 186,300x 60x60x24x365. This product is about 59x 10^{11} and shows that light reaches us from the star in question in 4.4 light-years. Some notion of the vast distances of the fixt stars may be obtained by considering that the light from some of them would not yet have reached us if it had begun to travel towards us on the traditional date of creation, 4004 B. C.

Probably one of the most bitter controversies which has ever been waged by scientists took place over the merits of the two rival theories of the nature of light. Sir Isaac Newton championed the older corpuscular theory and his influence was so great that it held the field against all comers for several generations. The bearing of the determination of the relative velocities of light in rare and dense media (see Fig. 3) upon the merit of these theories may be shown as follows: If light is regarded as made up of material corpuscles it follows that when these are passing thru a medium which is optically denser than air its velocity will be greater than in air. It is well known that if a body were to pass thru space with a certain constant velocity and then come near enough to the earth to be under the influence of gravity it would receive a certain acceleration so that it would strike the ground with its velocity considerably increased. In some such fashion as this, altho it must be confest the analogy is not a perfect one, light would travel faster in a denser than in a rarer medium if it were material in its make-up. On the other hand, if light is wave motion it would pass more slowly thru the denser medium just as water waves are retarded in their progress when they strike a sandy beach. If, therefore, it could be determined which situation exists the question regarding the nature of light would be settled. This problem was undertaken by Foucault who showed conclusively that the velocity in the denser medium was less than that in the rarer medium and by Michelson who made the experiment a quantitative one and showed that these velocities were in proportion to their refractive indices. In passing it may be noted that in the case of carbon bisulfid a result of 1.758 was obtained which is about seven per cent higher than the known value of its refractive index. About the time that Michelson was working on his experiment Lord Rayleigh showed mathematically that there was considerable difference in the velocity of a wave if we compared the velocity of the individual wave with the velocity of the waves as a group. By use of mathematical processes he reached the conclusion that in the case of such liquids as carbon bisulfid the ratio of the velocities would be as 100 to 93. When this correction was applied it checked very closely with the result of Michelson's

(*Continued on page* 1243)

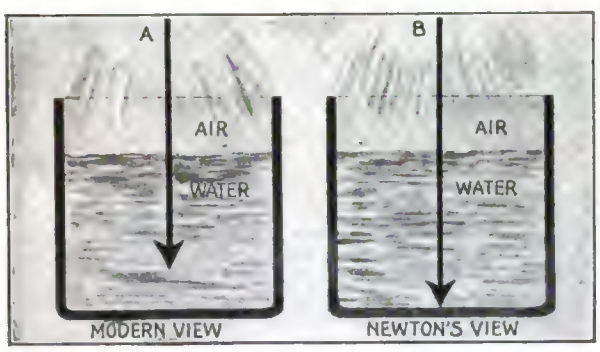

Fig. 3. Illustrating the Two Views of the Velocity of Light. By the Modern Theory, Light Travels About 75 Per Cent as Far in Water as It Does in Air, in the Same Length of Time. Newton Held the Reverse of This Theory.

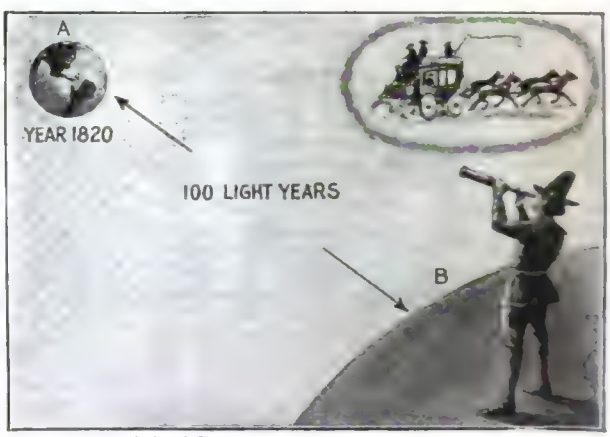

Fig. 4. An Observer on the Planet "B" Would Witness Events Which Happened 100 Years Ago If He Looked Thru a Powerful Telescope and Saw the Earth at the Present Day. This Assumes That the Observer at "B" Was Distant 100 Light-Years from the Earth.

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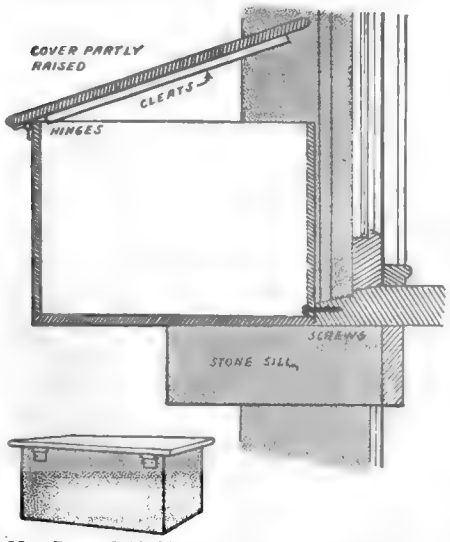
Home Mechanics

Conducted by WILLIAM M. BUTTERFIELD

Window Refrigerator

WE show in our illustration, a simple packing case or box of any convenient size converted into a window refrigerator by adding an overhanging hinged top (made from a larger packing case) and covering the whole with oilcloth, zinc



Mr. Butterfield Shows the Home Mechanic, in the Illustration Above, How to Construct a Particularly Efficient Window Refrigerator. This Window Refrigerator Will Prove Efficacious in Both Winter and Summer, and Is Suitable for Holding Milk Bottles, Meats and Other Foods.

or sheet tin, the latter to be painted so as to prevent rusting. The shape shown, with its top and other parts, has proven after years of experience with various kinds of window refrigerators to be the most practical, as it sheds rain, snow and dust sufficiently well, besides being easily operated. This is essentially a winter refrigerator, to be used without ice, but can be made with a lining (ice-box fashion with sawdust filling) to occupy a similar position, providing a dripping drain pipe is not objectionable. When ice is used, however, the refrigerator should be placed in a window not reached by the sun.

By nailing cleats on the sides and cutting shelving pieces provision may be made for shelves as desired. It would be well to use some thin felt at the joints, as it is quite essential to have it water-tight. It may be advisable to have a ventilating pipe, an inch in inside diameter, inserted through the bottom.

It is of interest to note in this connection, that a quantity of work has been done on the subject of making furniture and household appliances out of packing boxes. For one thing they start the constructor with some square angles—bad squaring being a failing of the amateur.

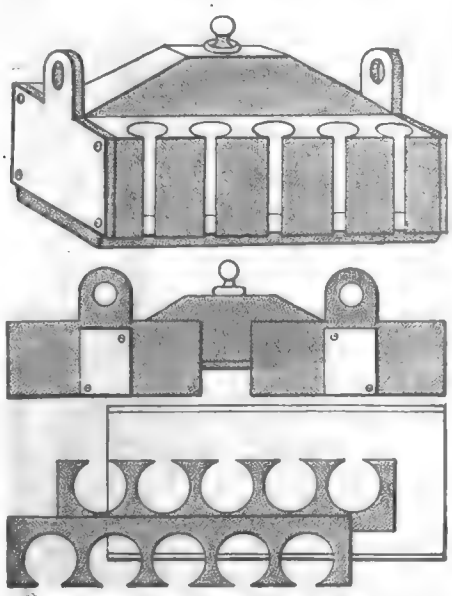
Card and Chip Case

The card and chip case usually sold has the disadvantage of providing small storage space for cards, although keeping the chips in a most desirable position. The home-made device shown in the illustration provides both a chip holder and a central box for holding several packs of cards. It is also possible to store a cribbage board or narrow score-cards for bridge with the cards. The size of this case depends upon the desired storage space for cards and the size of the chips used, the plan of construction remaining the same in all cases. In boring the holes for the chip-holders allow at least ⅛ inch over the diameter of the chips so as to give an easy fit, bore the holes from both sides of the wood, thus letting the bit break thru the center of the block and in a block wide enough to include all of each hole. The slots for removing the chips are made after the holes are bored by sawing the wood so as to cut part way into the holes.

Care must be taken in boring the holes to keep them in line, as if they make angles with each other in the middle of the block, the job will be spoiled. The holes should be properly done in a drill press.

There is a peculiar fascination in working out wooden articles from the solid; it calls for good tools well sharpened as well as for good workmanship. The result, too, gives a solid product that will last forever. It would even be possible for a good workman to make the side-handles out of the same block with the rest of it.

Mahogany or teak are excellent woods for the purpose. Black walnut is also good but may prove a little hard to work.



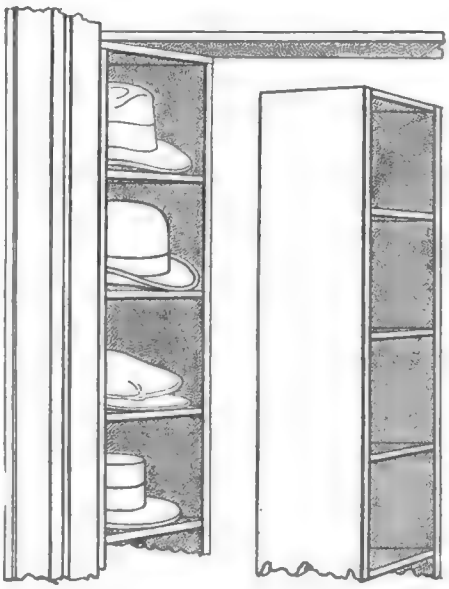
This Card and Chip Case Will Prove Most Useful and Also a Welcome Addition to the Library or Card Room, If It Is Constructed of Hard Wood Such As Mahogany, Walnut or Oak.

Hat Rack for Closet

Every man or woman with more than one hat finds it most difficult to keep these articles of wearing apparel in good condition, by the ordinary process of hanging them on a hook in the clothes closet. No other article seems to fall as easily or so inevitably get out of shape, but with the plan shown in the plate, this undesirable hat trouble is removed. A few pieces of lumber nailed or screwed together in the form of a series of boxes, open at the front and one on top of the other, occupying one or both of the commonly unused ends of a closet do the trick. This is the usual storage plan for protecting hats in the professionally equipt "cloak room"; here it is applied to your home closet; we know that our party hat is well taken care of in the cloak room, why not have all of our hats taken good care of in the home closet?

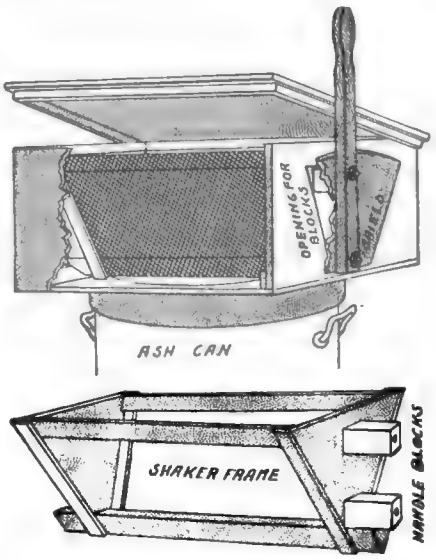
Ash Sifter

An ash sifter that can be depended upon to sift the finest cinders without distributing dust all over the premises is shown in the cut. It consists of a box with a hinged top; in the box two holes are cut, one in the bottom for the ashes to fall thru and one in the end for the shaking blocks to pass thru. The latter



Did You Ever Notice How Many Hats Have Been Ruined by Throwing Them One on Top of the Other in a Dark Corner of a Clothes Closet? Here Is a Way to Keep Each Hat in First Class Condition and Prevent Its Being Drawn Out of Shape.

opening is V shaped and acts also as "stops" when the blocks are oscillated along with the shaker frame by its attached handle. To prevent dust coming thru this opening a moving shield is bolted to and between the blocks and handle on the outside of the box. The shaker frame with its attached wire netting oscillates on a "V" shaped base resting on two cleats with "V" notches, one at either end of the box as shown. The free ends of the boards round the bottom opening can be secured with metal oilcloth binder nailed to their ends within the opening.



A Home-Made Ash Sifter Illustrated Above, Is Simplicity Itself and, Contrary to Many Devices of This Type, Will Not Cover the User with Dust, Providing It Is Properly Made.

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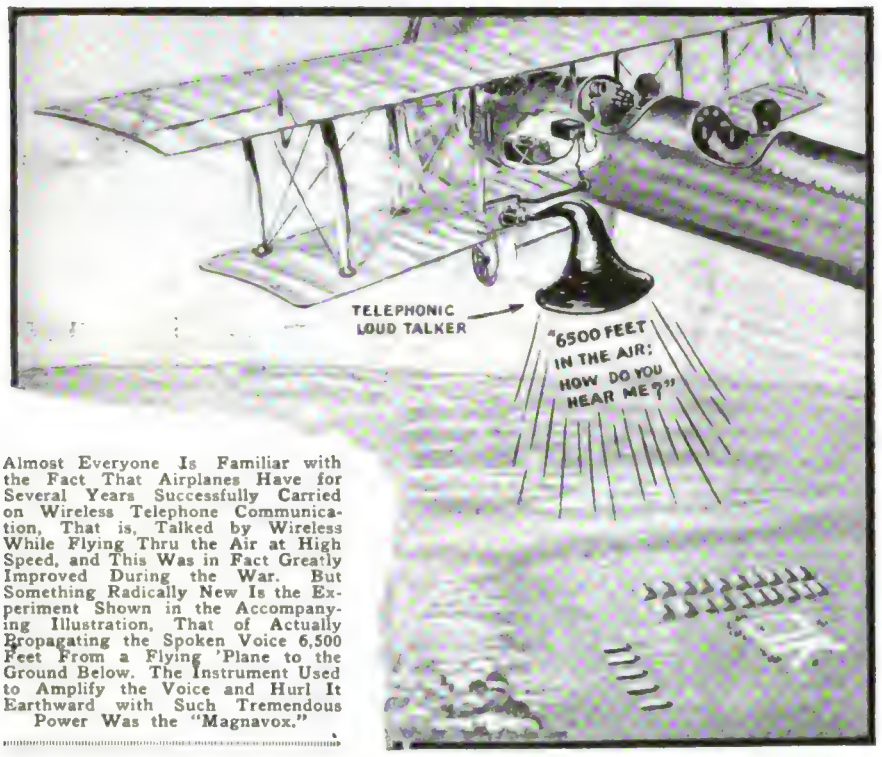
Hurling Voice from 'Plane Aloft

By H. E. METCALF



Almost Everyone Is Familiar with the Fact That Airplanes Have for Several Years Successfully Carried on Wireless Telephone Communication, That is, Talked by Wireless While Flying Thru the Air at High Speed, and This Was in Fact Greatly Improved During the War. But Something Radically New Is the Experiment Shown in the Accompanying Illustration, That of Actually Propagating the Spoken Voice 6,500 Feet From a Flying 'Plane to the Ground Below. The Instrument Used to Amplify the Voice and Hurl It Earthward with Such Tremendous Power Was the "Magnavox."

RECENTLY a Magnavox loud-talking telephone set was installed in an Army airplane, at Mather Field, California. The telemegafone, as it is called, was attached to the intermediate strut of the left wing and wired in position so that the mouth of the horn pointed downward and slightly backward. Two 8-volt batteries were used for the source of energy, and a standard 4-button Magnavox hand transmitter was used in the cockpit of the airplane.

A strong cross-wind of about 25 miles an hour was blowing on the field and the sky was overcast. While the motor was being warmed up, the voice could be plainly heard on the ground thru the roar of the motor, even when the motor was speeding up to 1400 R.P.M. The plane took off, and tests were made at altitudes varying from 500 to 6,500 feet at 500 foot intervals. During each test the pilot would cut his motor down to about 800 revolutions and messages were transmitted from the plane to the observers on the ground, with perfect distinctness.

It was noticed that at altitudes between 1,000 and 4,000 feet the voice was at its maximum strength, indicating better transmission from the higher altitudes. The last test took place between 5,000 and 6,500 feet and altho the voice was plainly heard, various noise conditions about the field were such that the message could not be distinctly understood. At all lower altitudes every word of the messages which were being sent down, was very clear.

It is to be noted that in these tests, no amplifier of any kind was used, and tests on the ground have indicated that the ratio of voice transmission thru the air between the standard V-2 outfits, such as was used in the plane, and the AC-3 amplifier outfit, is such that the amplifier will give distinct communication over a distance three times as great as the outfit without the amplifier. At altitudes of 500, 800 and 1,000 feet, the voice could be heard with a half throttled motor, with the plane making its own headway and not in a gliding position, half-throttle being sufficient to maintain forward speed without loss of altitude.

It is believed that this is the first time that communication has been had from a plane 6,500 feet in the air by means of the actual voice, of either the pilot or the observer. Extensive experiments are now under way for their permanent installation.

The Photo-Ratiograph Analyzes Vibration

IN the Bureau of Engraving and Printing, Washington, D. C., one of the principal objects to be seen, is the famous "surface lathe" or engraving machine. This machine, by imparting various motions to a cutting point, can produce the most marvelous scroll work designs on a metal plate, used as the base for engraving currency, bonds, postage stamps and the like.

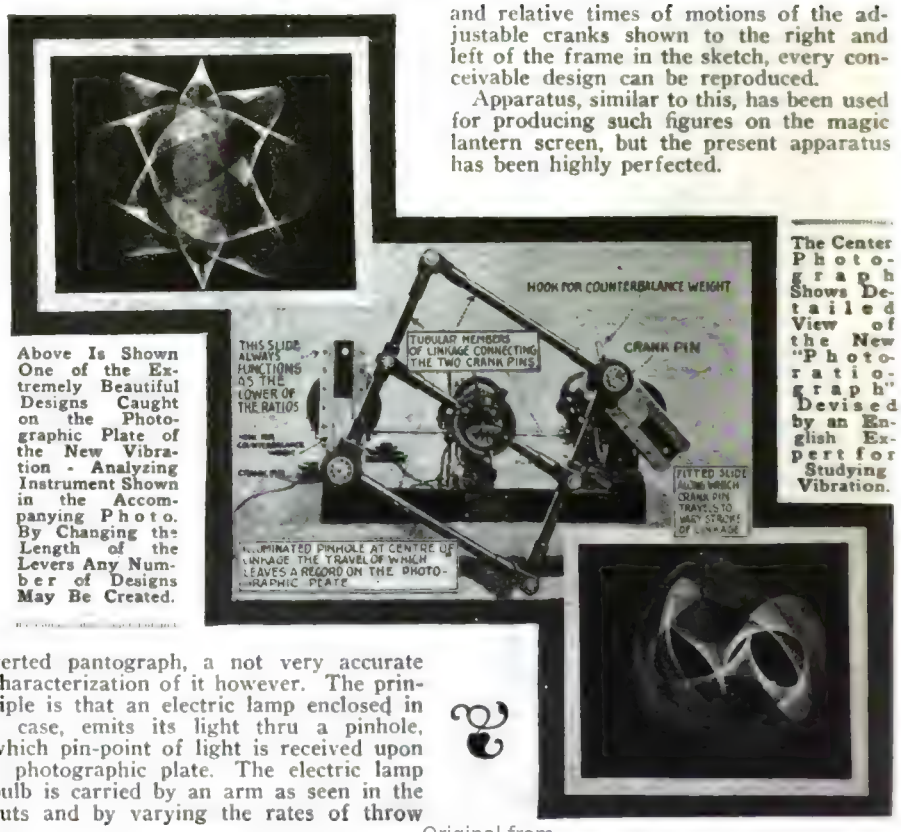
If we imagine a point or a tool moving in one direction, back and forth, it will of course, make a straight line. If simultaneously with this motion, another motion at right angles to the other, exactly the same in extent and timing, is imparted to it, it will form a circle.

If the plate on which the circle is normally formed, is caused to traverse the top of the machine, without moving the point from its regular path, a series of approximate circles will be formed, making what would be a very excellent border.

By imparting various motions to the engraving tool or stylus, there is absolutely no limit to the number of designs and the complications of the same which may be produced. There are probably no more than two or three men in the United States who can operate the famous engraving machine alluded to in the Bureau of Engraving plant, so as to get from it its full capability.

An English experimenter, Mr. A. C. Banfield, has developed an instrument for producing these designs by photography. The instrument is called the "photo-ratiograph." It has been described as an inverted pantograph, a not very accurate characterization of it however. The principle is that an electric lamp enclosed in a case, emits its light thru a pinhole, which pin-point of light is received upon a photographic plate. The electric lamp bulb is carried by an arm as seen in the cuts and by varying the rates of throw and relative times of motions of the adjustable cranks shown to the right and left of the frame in the sketch, every conceivable design can be reproduced.

Apparatus, similar to this, has been used for producing such figures on the magic lantern screen, but the present apparatus has been highly perfected.


HOOK FOR COUNTERBALANCE WEIGHT
TUBULAR MEMBERS OF LINKAGE CONNECTING THE TWO CRANK PINS
CRANK PIN
THIS SLIDE ALWAYS FUNCTIONS AS THE LOWER OF THE RATIOS
FITTED SLIDE ALONG WHICH CRANK PIN TRAVELS TO VARY STROKE OF LINKAGE
ILLUMINATED PINHOLE AT CENTRE OF LINKAGE THE TRAVEL OF WHICH LEAVES A RECORD ON THE PHOTOGRAPHIC PLATE

Above Is Shown One of the Extremely Beautiful Designs Caught on the Photographic Plate of the New Vibration - Analyzing Instrument Shown in the Accompanying Photo. By Changing the Length of the Levers Any Number of Designs May Be Created.

The Center Photograph Shows Detailed View of the New "Photo-ratio-graph" Devised by an English Expert for Studying Vibration.

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Practical Chemical Experiments

By PROF. FLOYD L. DARROW

CRYSTALLIZATION

THE processes of crystallization are to be ranked among the most important agencies known to the science of chemistry. The term crystallization is used to designate the production of crystals, often by the slow separation of a substance in solution from the liquid in which it is dissolved, the substance thereby assuming a definite and symmetrical form. This process can be brought about by a physical change in the condition of the solvent, either a change of its temperature or a diminuation of its volume. Just why substances should thus separate in some regular geometric shape is one of the unsolvable mysteries of our earth. This phenomenon, however, contributes much to the beauties of nature. Water vapor in condensing at temperatures below freezing takes the form of delicate crystals of marvelous beauty and exquisite design. Here there is no question of solution. In those immense, subterranean laboratories of Mother Earth, the vast resources of mineral wealth have been slowly crystallized during countless ages of past geologic time. Diamond is only carbon crystallized into rare and beautiful form by tremendous heat and pressure developed within the crust of the earth. Costly gems, so highly prized as objects of ornamentation, are the products of natural and little understood processes of crystallization. In accordance with the eternal and infallible laws of the universe the molecules of all crystalline substances are constantly being marshalled into six simple plans or systems. The six systems with their various axes are shown in Figure 1. Two examples of each system are shown. They are designated as follows.

1—Isometric or regular system (a). Three equal axes, all at right angles.

2—Tetragonal system (b). Two equal axes and one of different length, all at right angles to each other.

3—Orthorombic system (c). Three unequal axes, all at right angles to each other.

4—Monoclinic system (d). Two axes at right angles, and a third at right angles to one of these, but inclined to the other.

5—Triclinic system (e). Three axes all inclined to each other.

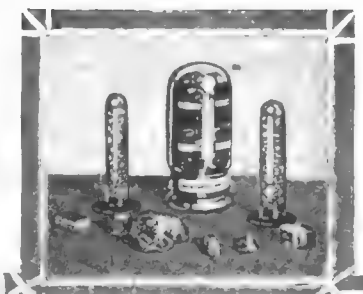
6—Hexagonal system (f). Three equal axes in the same plane, intersecting at angles of 60 degrees, and a fourth axis at right angles to all of these.

Every crystalline substance will be found to have its faces and axes corresponding to one of these six systems.

But aside from the beauty of crystals in themselves the process of crystallization is one of immense importance in the purification of chemical compounds. By crystallization and recrystallization many times repeated Madame Curie succeeded in separating from several tons of the mineral pitchblende, a few hundredths of a gram of a substance of intense radioactive powers and thereby discovered the new element, radium.

When a substance crystallizes from a

(*Continued on page 1237*)



Several Forms of Crystals, Calcite, Alum, Quartz, etc., Are Shown Scattered Upon the Table, While Crystals of Potash Salts May Be Seen in the Specimen Jars. Note Particularly the Manner in Which the Large Jar Is Labelled.

To Right: Obtaining Pure Iodine from Impure Iodine Compounds by Heating. Iodine Passes Upward as a Gas and Crystallizes Immediately Upon the Cool Surface of Inverted Funnel.

To Left: Dropping a Tiny Crystal of Alum in a Super-Saturated Solution of the Same Chemical. The Liquid in the Flask Becomes Solid Immediately.

Determining the Amount of Water of Crystallization in a Chlorid Crystal.

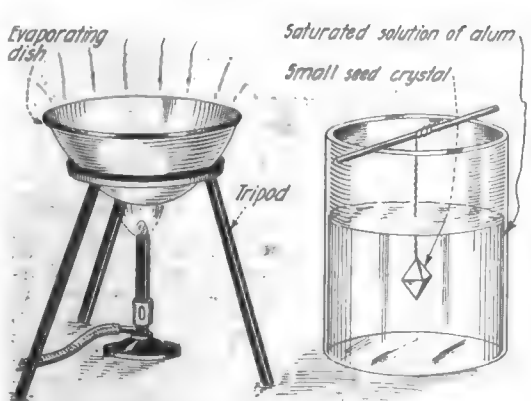


Fig. 2

Preparing Crystals of Alum with Evaporating Dish Supported Over Bunsen Burner.

Fig. 3.

Growing a Crystal of Alum in a Saturated Solution of Alum.

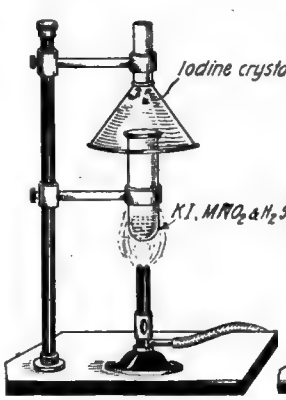


Fig. 5

Preparation of Iodine Crystals—A Simple and Interesting Experiment.

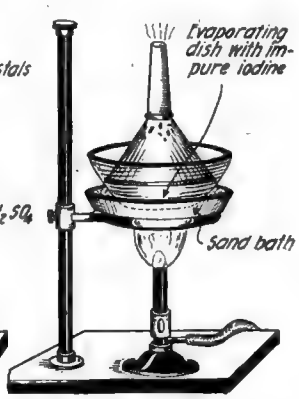


Fig. 6

Preparation of Pure Crystals of Iodine from an Impure Sample.

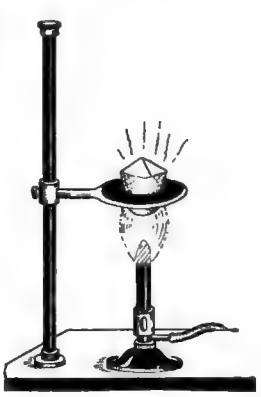


Fig. 7

Determining the Percentage of Water of Crystallization.

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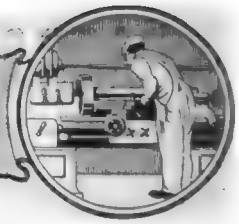
THE CONSTRUCTOR



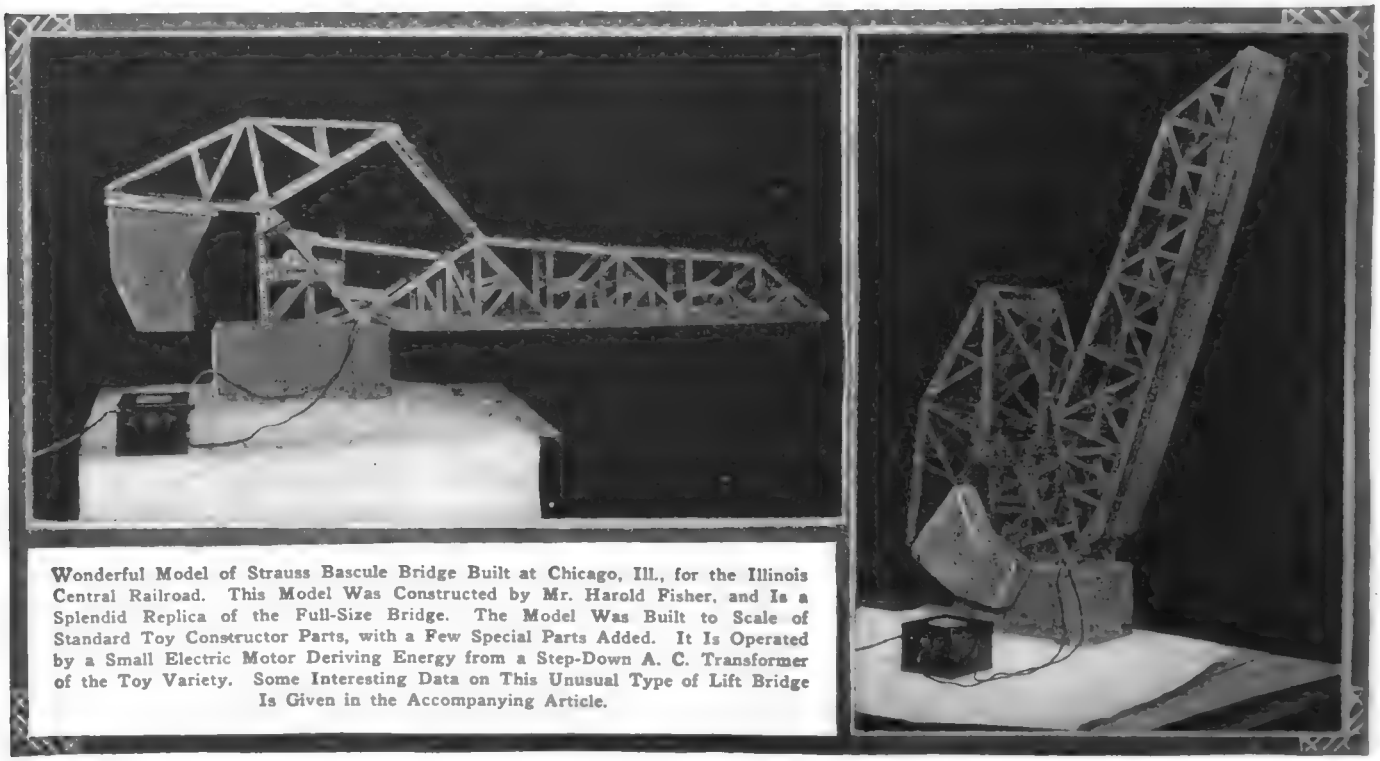
Model of The World's Longest Jack-knife Bridge

THE model bridge shown in the accompanying photos is one of the finest the editors have ever seen. The model was constructed by Mr. Harold Fisher of Chicago, Ill. The bridge is raised and lowered by a small electric motor and the members used in building the model are all standard parts, such as supplied in toy engineering outfits for boys. These miniature steel beams, bolts and washers are daily proving more valuable to engineering students, designing engineers and architects, for building working models such as this, which often expose defects in design where blueprints do not.

This bridge across the Chicago River at 16th St. is a double track, single leaf, Strauss Bascule, built for the Illinois Central Railroad. C. H. Norwood of Chicago installed the electrical equipment and air devices.

The moving leaf has a length of 260 feet, center to center of bearing points. To counter-balance this enormous mass of steel, a counter-weight of over 2,000,000 pounds was required, and was built upon a rocker-arm, which, in turn, was supported by a triangular tower. The substructure was built 11 feet into bedrock which was 30 feet below water level. The power for operating the bridge was derived from two 150 horse power alternating current motors, 440 volts, three phase, 60 cycle circuit. For emergency use, a 62 horse power gas engine was installed.

In the open position, the bridge has an opening angle of 83 degrees. To gradually check the movement as it approaches the highest point, air bumpers have been used in addition to the regulation air brakes. In closing, air buffers also take up the shock. Air is supplied to the regular and emergency brakes under 125 pounds pressure by a 25 cubic feet, directly connected, motor driven compressor with automatic governor and unloader. The storage capacity consists of a 65 cubic foot steel tank. Lock motors and main lifting motors are controlled thru limit switches at the ends of their respective travel. The circuit for the lifting motors is broken when the bridge is within 15 degrees of closing, but it is then completed with a push-switch which short-circuits the limit switch and the bridge closes, hits the limit buffers, rebounds, closes again and is then locked. The master control completes the circuit for 5 accelerating and reversing contactors of each main-lifting motor. These are of the magnetic type. The signal, locking, braking and lifting motors are all interlocked, thus minimizing any possible accidents to the zero point.



Wonderful Model of Strauss Bascule Bridge Built at Chicago, Ill., for the Illinois Central Railroad. This Model Was Constructed by Mr. Harold Fisher, and Is a Splendid Replica of the Full-Size Bridge. The Model Was Built to Scale of Standard Toy Constructor Parts, with a Few Special Parts Added. It Is Operated by a Small Electric Motor Deriving Energy from a Step-Down A. C. Transformer of the Toy Variety. Some Interesting Data on This Unusual Type of Lift Bridge Is Given in the Accompanying Article.

Umbrellas Serve As Sound Reflectors

A VERY singular experiment which it is interesting to carry out in the open is possible with two umbrellas and a couple of chairs. The umbrellas are opened up and the covers *well soaked with water*. Then the extreme ends are tied on to the backs of two chairs in the manner shown in the illustration. The umbrellas are placed fifteen or twenty feet apart, the insides facing each other. It is essential that the two umbrella-sticks should be in alignment, and to make sure of this stretch a piece of white thread between the two. Then let a person stand at each chair and adjust things until the line of thread is perfectly straight.

Using Two Umbrellas As Sound Reflectors in Acoustic Experiments.

Two experimenters should take up a position with the head inside each umbrella. Keep the mouth or ear within an inch or so of the sliding attachment. Words spoken in quite a low whisper are heard distinctly at the other umbrella, even tho this may be twenty feet away. Curiously enough, the sound does not seem to come from its real direction, but appears to issue from the umbrella to which one is nearest. More strange still a third person kneeling down between the two umbrellas midway hears not a word that is said. The covers of the umbrellas should be kept well dampened or the sound will not be thrown back in the manner indicated.

Contributed by S. LEONARD BASTIN.

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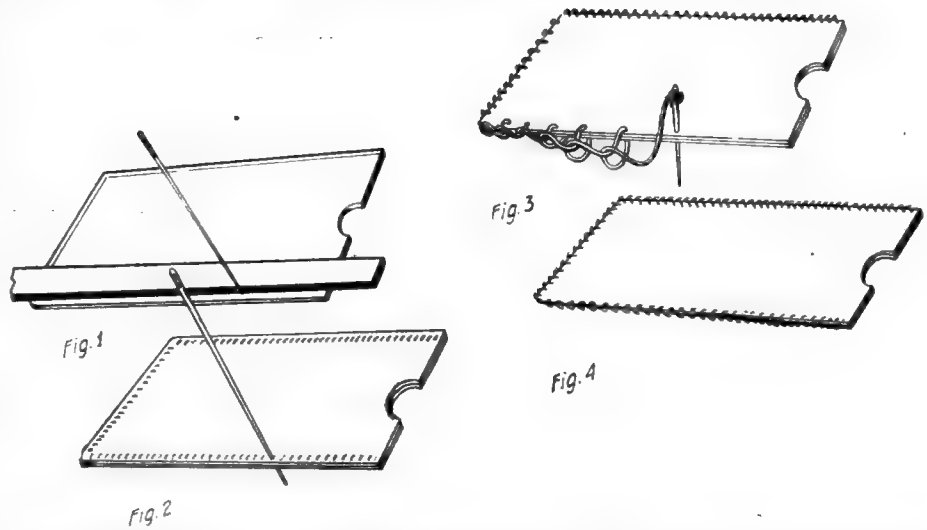
Transparent Case for Reference Notes

At times I have found the ordinary note or memo book impractical, while the device I shall describe has proved highly practical, convenient and simple to construct. It is in effect an improvement upon the practise of carrying notes, tables, formulas for frequent quick reference on small slips of paper or cards which ordinarily soon become worn and difficult to read.

Essentially the device consists of a small transparent celluloid envelope and a small supply of cards with which it may be filled as needed. This celluloid envelope protects the card, keeps the writing or printing fresh and legible, permits notes to be read from both sides of the card and makes the whole stiff and durable.

The regular 2"x3½" standard card is perhaps the most convenient size and may be secured in quantities of 100 or more from printers, stationers or paper houses at very small cost.

If a card of the suggested size is used, then the envelope is made of two sheets of thin transparent celluloid cut to 2 3/16" x 3⅝", and a semicircular thumb space is cut out of one edge. The celluloid may be purchased cheaply at art or drafting materials stores.



The Diagram Above Shows a Handy Transparent Case with Reference Notes, Which Can Be Easily Constructed by "Boy Scouts" and Others Who Have Use For Such a Case, But Who Do Not Desire to Pay the Price Asked For Them. The Case Consists of a Small Transparent Celluloid Envelope Together with a Supply of Cards with Which Each Case May Be Filled as Needed.

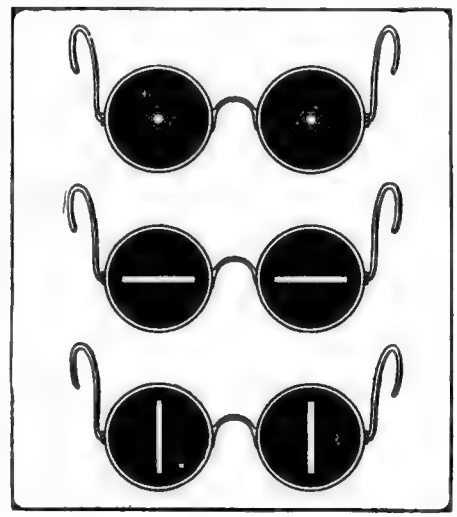
On one of these celluloid sheets, with a needle or other pointed instrument, a guide line is lightly scratched about 1/16" from the three edges as shown in Fig. 1. Place this sheet over the other and all along the scratched guide lines, with needle or other pointed instrument, pierce both sheets at once at intervals of about 3/32". (See Fig. 2.) Now follow with double-threaded needle, lacing both sheets together (Fig. 3), completing the envelope ready to use as per Fig. 4.

Contributed by C. NYE.

Curious Cardboard Spectacles

Some very singular experiments can be carried out with cardboard spectacles cut with different kinds of openings. The discs for the eye pieces are cut out of cardboard and these might be about two inches in diameter. The nose-rest or bridge is made from copper wire bent round in the right shape. The end of this bridge can be twisted into holes made in the sides of the discs. The bows are also made of wire one end of which is fixt to a hole in the side of the discs, and the other is bent round so that it will rest over the ears.

The discs are treated in the following manner. In one of the pairs of spectacles a hole is made with a pin right in the center of each disc. In another a horizontal slit is cut across as can be seen in the diagram, while in the third the slits are put in vertical fashion. The slits which should be narrow, can be cut out with a sharp chisel or a pocket knife.

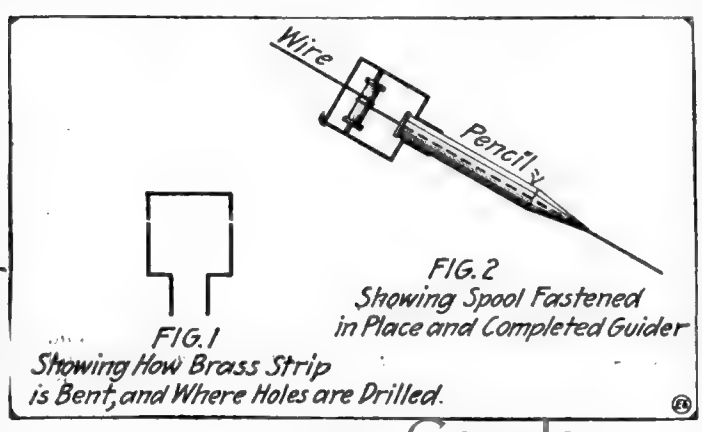


The effect of wearing these spectacles is very curious. With the pinhole pair the range in vision is somewhat restricted but, so far as distant objects are concerned, there is extreme clearness. It is possible to read print easily at three or four times the normal distance. In the case of the spectacles with the horizontal slit the field is much the same as usual, but only horizontal lines are to be seen clearly. Vertical lines cannot be discerned, or seem to be very confused in outline. Thus, the trunk of a tree is very difficult to locate, but any of the boughs that are more or less horizontal stand up with great clearness. When the spectacles with the vertical openings are put on a reverse effect is secured. Here it is only the vertical lines in houses, fences and trees that can be seen plainly. Thin lines disappear altogether. Thus a clothesline cannot be detected at all although the supporting posts are astonishingly clear.

Contributed by S. LEONARD BASTIN.

A Wire Guider for Winding Coils

A metal pencil known as a clutch pencil is first secured. This may be obtained at any stationery store for a few cents. First drill a hole in the end of the pencil opposite the end in which the lead fits. Next cut a piece of thin brass about five inches long and one-half inch wide, and then bend it in the shape as shown in Fig 1. Drill two holes in this strip at the point shown by the arrows and make a small axle which will fit in these holes. Slip a small spool—which serves to guide the wire—over this axle and solder the axle to the strip.


Wire
Pencil
FIG. 2
Showing Spool Fastened in Place and Completed Guider
FIG. 1
Showing How Brass Strip is Bent, and Where Holes are Drilled.

This Novel Wire Guider to Be Used in Winding Coils of Various Kinds, Is Readily Constructed From a Metallic Magazine Pencil of the Usual Type, One of Which Can Be Purchased at Any Stationery Store at About Ten Cents. The Wire to Be Wound on the Coil Is Given One Turn Around a Spool Pivoted on a Shaft at the End of the Pencil; It Then Passes Thru the Pencil and Onto the Coil. Besides Facilitating Accurate Winding of Coils in the Lathe at High Speed, this Scheme Entirely Eliminates Cutting of the Fingers.

After this is done, solder the ends of the brass strip to each side of the pencil. The wire to be wound is past around the spool once and is then led thru the entire length of the pencil and out the other end.

When a coil is to be wound, hold the pencil against the form and then turn the form which feeds the wire thru the point of the pencil.

With this arrangement the wire will go on very easily and if a little care is taken no trouble will be experienced from overlapping of wires as is the common trouble when winding coils with the fingers. Also no more sore fingers.

Contributed by HORACE C. LEEDS.

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Ozone--Its Liquid State

By JOSEPH H. KRAUS

ALTHO the liquefication of gases has been commercially employed for a number of years, the production of liquid ozone on a large scale has not met with any great success. The reason for this is that ozone as a liquid is a rather dangerous explosive, and the process for manufacturing the same is fraught with danger of explosions.

Ozone oxidizes substances much more rapidly than the gas from which it is obtained (oxygen), and it promotes spontaneous combustion of many substances which are permanent in oxygen itself. In those substances combustible in oxygen, when ozone is substituted for the other gas it offers a much greater and more vivid effect.

The interest in ozone is quite natural, because of its industrial use and the difficulty in obtaining it in a pure state. Before we can further delve into its production in liquid form, let us see how ozone can be employed and just what ozone is.

Ozone is an allotropic form of oxygen. Just what allotropism is, is rather difficult of explanation in a short article of this nature; however, suffice it to say that this word refers to two or more forms of the same element differing in properties. Thus, the diamond is pure carbon and yet has different properties from the forms of carbon which we are more familiar with. Therefore, we consider that carbon has several allotropic forms.

In nature, ozone probably does not appear in as great a quantity as three-tenths of a liter in a million liters of air. We know that this gas will easily yield oxygen in the atomic state and that it has extraordinary oxidizing properties. It will, for instance, immediately turn ferrous compounds into ferric compounds, and in order to show the extraordinary strength of ozone, we quote a few more striking examples. All organic matter in surface waters is readily oxidized by ozone, and ferric compounds therein contained leave a ferric hydroxide in suspension. Silver is readily oxidized at ordinary temperatures and nascent iodine is liberated from potassium iodide. Lead sulfid is oxidized into lead sulfate, and even mercury succumbs to the terrific power of this gas.

In this way, ozone presents us with a source of nascent oxygen and if it could be secured easily in liquid form, it would enable us to obtain the much desired nascent oxygen. In air there is always a repeated action between ozone and oxygen; the ozone changing to the latter gas and vice versa, even when under the influence of a high frequency machine. It is thus seen, that we can never get a high concentration of ozone in air as the former gas loses its unstable form and becomes oxygen again.

Therefore, liquid ozone is the only salvation. The effect of ozone upon rubber is to eat it thru in a few seconds, altho cork will withstand its action fairly well, unless the concentration of the ozone is extremely powerful. When speaking of the gas chemically, the concentration is not exprest in percentage but in grams per cubic meter.

For bleaching waxes, oils, and textiles, ozone is without a peer, and as a bactericide it is meeting with great success. Its use, as the latter, has been described from time to time in this journal. Both drinking water and bathing water have been purified successfully by but a slight quantity of the gas compared to volume of water.

It is interesting to note that certain bacteria such as the *bacillus subtilis*, and the *bacillus ramosus* are not affected by ozone. Fortunately for us, these germs are harmless. Another interesting subject, arises when we consider the odor of ozone. A question has often arisen as to whether we really smell this gas or whether the sensation we perceive is due to oxidation of organic substances in or around the olfactory nerves. Many observers have questioned the point and altho it has been almost definitely proven that the sensation is directly due to an oxidation process, there is still room for doubt.

The following fact tends to prove the opposite side of the theory. Ozone when taken in slight concentration does not oxidize the nerves; if it did oxidize them its odor should be entirely obliterated for one who is working in an atmosphere of the gas for a short time. Such, however, is not the case, and a person can work in an ozonized atmosphere all day and smell the gas continually. Its effect upon the sensitive membrane, lining the nose is, if anything, to create a super-sensitive membranous condition. Not alone does the action of the gas completely rid a room of odors but it destroys every living dangerous bacillus in the room.

Its effect upon vile odors is not a masking action, but a thoroly oxidizing effect, and odorous substances are burnt into non-odorous forms.

So much for the importance of ozone as a gas but when the liquefied gas is considered, we have a different story.

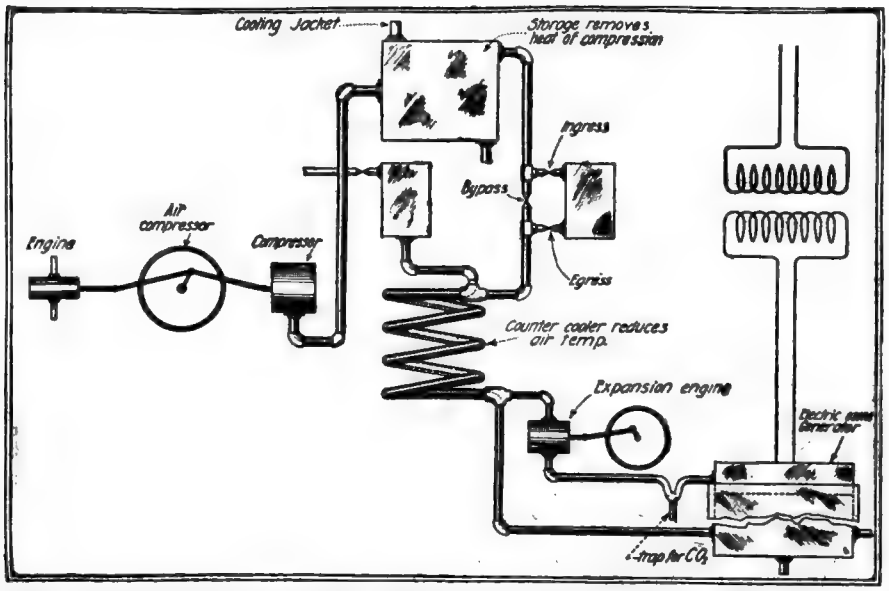
Some time ago, a very interesting patent upon that subject, was issued to Horace Dumars, who has experimented and produced liquid ozone on a large scale, at the time when Trippler and Linde, two authorities on liquid gas production, first appeared in the field.

This invention provides for the production of ozone is a pure state without the danger generally incurred in such installations. Its basic principle is rather easy of comprehension. Air in the apparatus is reduced to a temperature lower than that at which ozone liquefies, and yet at the same time higher than the liquefication point of either nitrogen or oxygen.

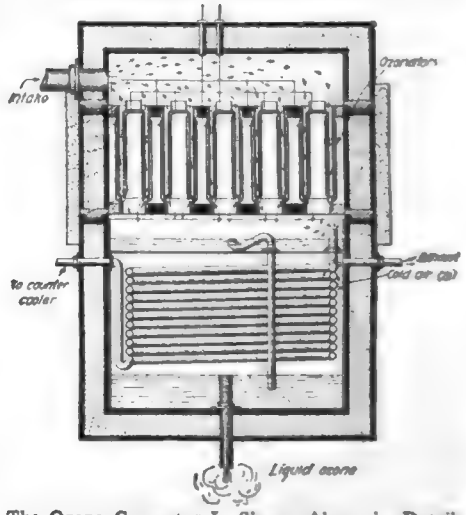
This temperature for ozone is minus 106° Centigrade; that of oxygen minus 179° Centigrade, and nitrogen minus 196° Centigrade. The diagram shown discloses the apparatus complete. The air is first taken thru a compressor where it is forced into a storage tank. Here the comprest air is allowed to cool by reason of its contact (thru the walls of the tank) with the atmosphere and the cooling jacket surrounding it.

The air then passes thru a dryer generally filled with liquid carbon dioxide where its water is removed. Here, its ingress and egress are regulated by valves, both ingress and egress openings being connected by a by-pass in case the same is to be placed in service.

(*Continued on page* 1258)



The Method of Making "Liquid Ozone" Directly, Is Clearly Shown in the Above Diagrams, and All the By-Products Formed During the Liquefication of Such Ozone Are Used Again in Other Parts of the Apparatus to Facilitate Its Production. Air is First Compresst by a Motor-Driven Compressor, and Then Past into a Storage Tank. From Thence It Travels to An Expansion Engine Which Has a Different Purpose, Described in Detail in the Accompanying Article. The Cold Air is Then Acted Upon by High Voltage Ozonators and "Liquid Ozone" is Immediately Produced.



The Ozone Generator Is Shown Above in Detail. The Air Coming from the Intake Passes Down Between Two Concentric Double-Walled Glass Tubes, the Coatings of Which are Connected to the High Voltage Generator. The Molecules of Oxygen are Changed to Ozone by the Action of the Current, and Immediately the Gas Liquifies.

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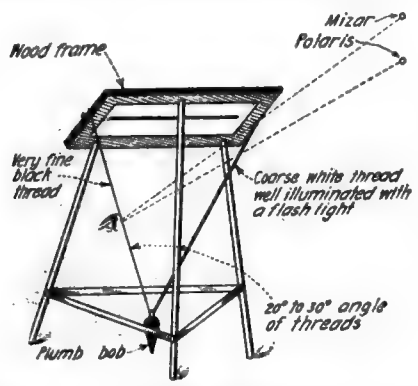
HOW-TO-MAKE-IT

This department will award the following monthly prizes: First prize, $5.00; second prize, $3.00; third prize, $2.00.
The purpose of this department is to stimulate experimenters toward accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department a monthly series of prizes will be awarded. For the best idea submitted a prize of $5.00 is awarded; for the second best idea a $3.00 prize, and for the third best a prize of $2.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $5.00

SIMPLE TRANSIT INSTRUMENT

A simple and very useful instrument for the amateur in astronomy, can be made according to the accompanying sketch, utilizing the optical phenomenon of the "entoptic" vision (inside the eye).



Here Is a Very Interesting Transit for Lovers of the Skies. A Frame, Stand, Plumb Bob and Pieces of Black and White Threads Complete It.

To find the meridian at night, some moments before any one of the two stars, Zeta of the Ursa major (Mizar) or Delta of Cassiopeia pass over the meridian thru Polaris, follow them with the plumb line plane; so that one of these and the Polaris will be on the same vertical plane and after this instant for about seven to eight minutes more; at this moment the plumb line plane is exactly in the meridian plane of the place.

The eye must be placed behind the fine black thread at a distance from it, of two to ten inches (nearer than the distinct vision of the observer's eye) so that the black thread will appear when looking at the star or other object as a series of very fine vertical lines of diffraction (this is the "entoptic" vision of the thread). The star is seen to approach to the "entoptic" image of the thread which the observer maintains in the center of vertical axis of the coarse white thread, soon the star touches one side of the multiple image of the black thread, passes over it and comes out of the other side without ceasing to be visible at any moment of its passage over the image of the thread. When it passes over the center of this image, is when the plane is in its right place.

Leaving the instrument in the meridian, passage of the stars, moon, sun, etc., can be watched, and solar apparent time at 12 can be taken when the shadows of the two threads combine in one as received on a screen placed in a convenient position; local mean time or standard time is then taken by adding or subtracting the correction of the day and latitude of the place.

To avoid vibration of the plumb bob it can be submerged in a pail of water. At night the coarse white thread must be very well illuminated. A flashlight is ideal.

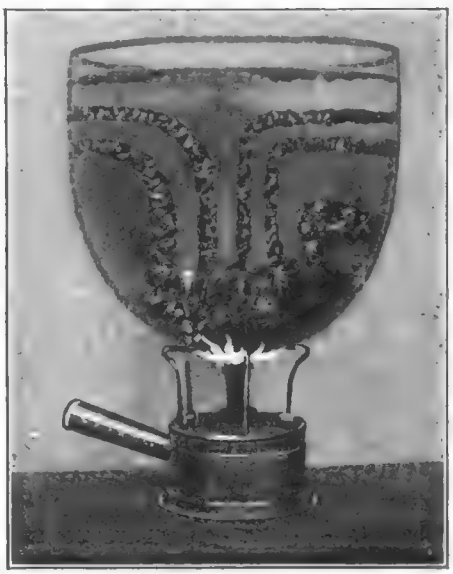
Contributed by RAFAEL GABALDÓN.

SECOND PRIZE, $3.00

A CHARMING EXPERIMENT

In science the term convection currents is employed to describe the movements which take place when water, or any other liquid, is being heated. When a vessel of water is placed over a fire the layers at the bottom first of all become warm and, owing to their lightness, these rise steadily to the top. The cold water which is heavier streams downwards to take the place of the liquid that has come up. It is easy, by following a simple experiment, to watch the course taken by the convection currents. Secure a glass vessel with a rounded bottom containing water and place this over a small spirit flame. Then throw in a few fragments of any solid coloring matter such as aniline, cochineal or litmus. These pieces sink to the bottom where they tint the streams of water that are rising upwards owing to the warmth. The convection currents which are then plainly seen assume the most graceful curves and the whole effect is extremely beautiful.

Contributed by S. LEONARD BASTIN.



Solid Coloring Matter in Water Will Give This Novel Effect When the Water Is Heated.

ACID PROOFING

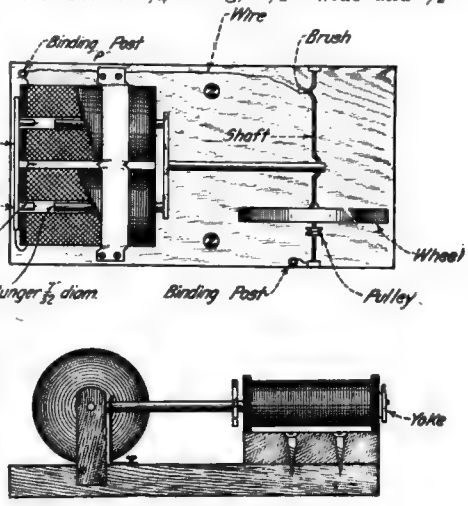
In order to prevent cement or wood laboratory tables from being attacked by acids apply to the tables three or more coats of finely powdered asbestos mixed with a slightly alkaline solution of waterglass (sodium silicate). This will give a surface, which on drying is not attached by even the strongest mineral acids.

Contributed by J. H. K.

THIRD PRIZE, $2.00

HOW TO MAKE AN ELECTRIC ENGINE

The base of this battery engine consists of a board 4¼" long, 2½" wide and ½" thick. Another board 1½" long and 2½" wide and ½" thick is secured to the larger one by screws. The wheel is made of lead, copper, or brass and is 2" in diameter. Two coreless magnets having a ¼" hole in them are placed on the platform and secured by a strip of brass or tin.



This Small Battery Motor Can Readily Be Made by the Experimenter. It Will Operate on a Couple of Dry Cells for a Long Time.

The iron plungers are made from a soft iron rod 7/32" in diameter and ¾" long. The right hand magnet is connected to the brush and the left hand magnet is connected to binding post "P." The shaft is made of heavy brass or steel wire bent into the shape shown in the sketch and is 2" long after being bent. A soft iron plug ¼" x ¼" is inserted in the back end of each solenoid, and three holes are bored into the plugs; one 1/16" in diameter, containing a piece of brass wire; and two 3/64" holes used as vents. A piece of ½" x 1/16" iron strip, 2" long, should join the plugs as a yoke.

Contributed by LESTER E. KENDALL.

INK ERADICATORS

First solution, saturated aqueous solution of borax (two ounces), citric acid (one ounce), and water (eight ounces); the second solution is composed of three ounces of chlorinated lime, saturated aqueous solution of borax (two ounces), water (eight ounces). Another excellent ink remover consists of potassium chlorid, potassium hypochlorite (KClO) and oil of peppermint mixed in equal parts for solution A. Sodium chloride, hydrochloric acid and water in equal parts for solution B. To use: moisten the spot with A, allow to dry and then pencil over lightly with B. Rinse in clear water. Contributed by J. H. K.

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Interesting Chemical Experiments

By O. IVAN LEE

The Magic Lung-Tester

Find a large bottle which is square, or better, oblong, in cross-section and the walls of which appear to be thin enough to allow of a slight amount of "give" or yielding when strongly prest. You can not see any movement of the glass but can sense that it is not as solid as that of an ordinary round bottle when squeezed between the fingers. Also get a straight glass vial small enough to slip easily into the neck of the large bottle, a tight-fitting cork stopper for the latter, a piece of glass tubing about six inches long and a quarter of an inch in outside diameter, about six inches of rubber tubing to fit over the glass tubing, and a little piece of thin transparent celluloid or mica.

This Magic "Trick" Lung Tester Is Constructed From a Large Glass Bottle Fitted with a Tight Fitting Cork and a Glass Tube, Together with Rubber Hose Leading to a Hole in the Center of the Cork as Shown. A Mica Disc Is Placed in the Center of the Hole Thru the Cork, and Between the Ends of Two Pieces of Glass Tubing, So as to Prevent a Flow of Air From the Rubber Tube Down into the Bottle.

Using a small rat-tail file, make a hole in the cork into which the glass tube will slide snugly. With a sharp three-cornered file nick the glass tube about an inch from one end, break it, and file one end of each piece flat and smooth by rubbing down on a flat file with a little water. Cut out a little circle from the celluloid or mica, just the size of the glass tube. Fill the large bottle brimming with water. In a glass jar or pitcher, float the little glass vial mouth downward so that the bottom of the vial is flush with the surface of the water in the dish. This can be done by admitting more or less air into the vial, and when the best adjustment is reached, the merest touch to the floating vial will send it downwards only to bob up again. While the little bottle is floating on the surface, slip your middle finger very carefully under the mouth; putting your thumb on the bottom end transfer it to the large bottle. Be careful not to press any water up into the vial when you put your finger over it, and also not let any air in when you are floating it in the neck of the large bottle. Push about half the water out of the neck of the large bottle (do not try to pour it out), and slowly push in a cork without any hole in it. At a certain point you will be surprised to see the little bottle quickly drop to the bottom; and it will stay there until the cork is drawn out a little, when it will bob up again. Push the cork in again, little by little, until you find that just a twist is enough to start the vial down. If this adjustment has been carefully made, the little bottle delicately floated, and the large bottle properly selected, you will be astonished to find that you can make the little bottle go up or down or stay anywhere commanded, just by more or less pressure on the flat sides of the big bottle. The thumb and fingers of one hand should be sufficient to do this.

Arrived at this point, take out the cork and replace with the cork with the hole in it, first inserting the glass tubes with the mica or celluloid circle between the filed ends hidden inside the cork.

The upper tube should be five inches long, the lower one, one inch, and should project but a very short distance (⅛" to ¼") *i. e.*, it should not touch the water. Adjust this cork with the tubes just as you did the other, so that a fairly strong pressure on the big bottle will make the diving bottle submerge.

Finally, slip on the rubber tubing on the upper tube and you are ready to try out your "lung tester" on the young man who prides himself on his chest measurement. Demonstrate how easily you can "blow" the little bottle down, and then pass the "tester" to him.

He will doubtless get very red in the face, but will have no luck at all. After he is discouraged a little, remove the rubber tubing and let him peer down through the glass tube, after which he will be more mystified than ever.

If the cork is a good one, and the connections are carefully made and air-tight, the apparatus will work without any adjustment for a long time; but of course it is always best to make a private trial before a public exhibition.

How to Prepare the Essential Oil of Cloves

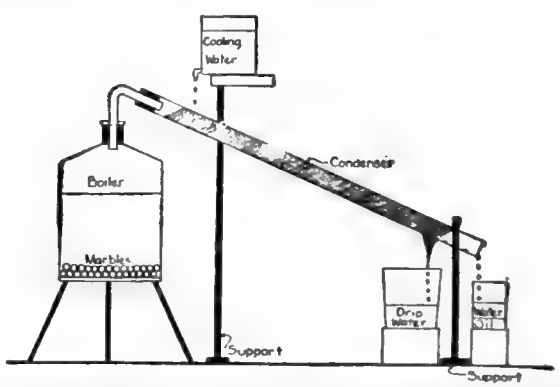
In the spice known as cloves consisting of the dried flower-buds, there is a very considerable amount of an oil of a spicy, agreeable odor, reminding one of carnations. It is very interesting to obtain this oil in a pure form by the process called *steam distillation* and this operation may be carried out very successfully with comparatively simple apparatus.

After obtaining several ounces at least of whole cloves from the grocer, grind them in a coffee mill. Then get a tin can (one with a conical top is to be preferred) of a capacity of about two quarts, and put in enough marbles or small clean pebbles to cover the bottom to a depth of an inch or so. After this, get a section of gas- or water-pipe between a half and one inch in diameter outside, and about six feet long, and clean it out inside as thoroly as possible; do the same to the can. With a round file, drill a hole in each of two clean corks fitting the ends of a short bent tube of glass, brass or copper. This gooseneck tube, as it is called, is to connect the outlet of the "boiler" with the upper end of the gas-pipe which is placed in a sloping position. Support it firmly at top and bottom with wooden uprights. Loosely wrap the whole length of the pipe between the points at which it is supported, with a long strip of soft absorbent cloth, letting the lower end hang down in a pail or large pan. Above the upper end of the gas-pipe which is to serve as the condenser for the steam, place a large tin can with a small nail-hole in the bottom. Have this opening of such a size and in such a position that as much water as possible soaks the cloth and runs down into the pan below without dripping off much on the way. If any trouble is experienced in adjusting the flow of cooling water make the slope of the pipe a little steeper. Provide a glass jar or vessel to receive the condensed water and oil coming from the open end of the pipe. Some source of heat such as a gas or kerosene stove must, of course, be provided to boil the water in the boiler.

When everything has been set up as described, fill the boiler can about half full of water, put in the ground cloves, connect the bent tube to the sloping gas-pipe, and light the fire.

As soon as the water comes to a boil, start the water running down the condensing pipe. The cooling water may be dippered back into the upper reservoir from time to time, but after a while it will probably get so warm that steam comes from the end of the pipe. Fresh cold water should then be used. Too big a fire, too

(*Continued on page* 1236)



Laboratory Apparatus Set Up For the Preparation of the Essential Oil of Cloves. The Process Here Shown Is Known as the "Steam Distillation" Method and the Apparatus Required Is Very Simple.

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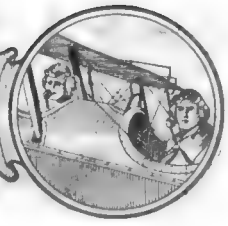
RADIO DEPARTMENT



Radiophone on Motor Car

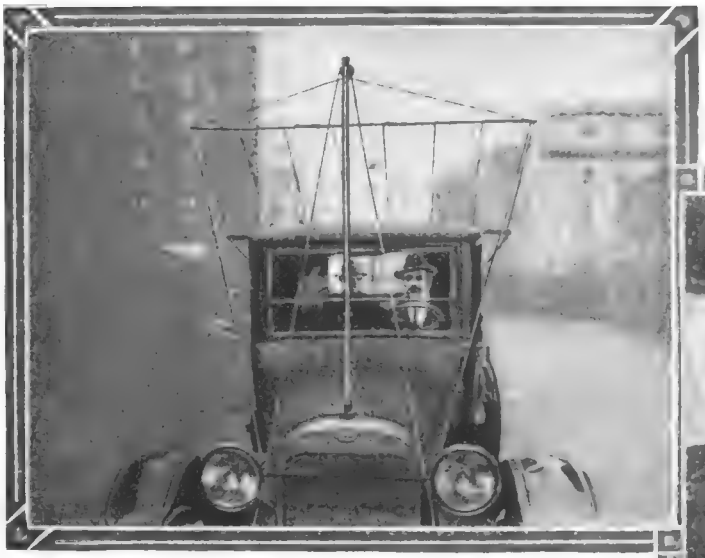


Photo at Left Shows Disposition of Antenna Wires on Automobile as Worked Out by Two Young Radio Experts of Omaha, Nebraska. Intercity Wireless Communication Is Possible When a Sufficiently Sensitive Receiving Set Is Used.

View of Interior of Radio-Equipt Automobile Is Shown Below. Several Stages of Audion Amplification Are Utilized to Boost the Strength of Signals.

WHEN Wilbur R. Cramer and Fred W. Swain, both of Omaha, Neb., take their evening ride in their automobile now, they can chat with friends in nearby cities by wireless telephone.

This pair of amateur radio inventors has completed an apparatus, on which they have been experimenting for several years, which can be attached to their automobile and operated while traveling.

Tests of the telephone and telegraph instruments which they have attached to their automobile have proved successful, and Cramer and Swain now plan to place their invention on the market.

Their experiments with amateur wireless telegraphy began four years ago while they were attending the Omaha High School of Commerce. Following completion of their courses there both young men have continued their intensive study and have several inventions already in operation.

During the war, all United States Navy wireless sets were equipt with a standard recording dial which was first perfected by young Cramer, it is said. One of these dials was used by the crew of the NC-4, which was the first air craft to complete a non-stop trip over the Atlantic ocean.

While experimenting with their wireless telephone apparatus for automobiles, the young men have been testing out another invention, which controls the operation of any standard make automobile by wireless.

Another channel for their wireless efforts will be the conveying of orchestra music from one Omaha motion picture theater to another and the transmitting of a speech by a nationally known orator while in Chicago to a theater in Omaha.

The young men have organized a radio company to place their inventions on the market. They have received recognition for their efforts from several of the national radio magazines. Both of these young men are 20 years old.

Radio Aids to Navigation

ADMIRAL W. H. G. BULLARD, U. S. N., director of naval communication service, in a paper read before the Franklin Institute said that wireless telegraphy is making navigation simple and safe.

"There will be a time when ships will be without chronometers and will be in constant wireless touch with New York until they reach the British Channel," said Admiral Bullard. "This is not a dream; it is near at hand.

"By means of the radio compass a ship can get her bearings, when she calls for them anywhere along the coast of the United States. This instrument has already saved ships which were headed straight for the shore.

"The depth of water under the ship can now be accurately determined by the hydrophone, which works on the reflection from the ocean bottom of the sound of the ship's propeller. By this device shallow water can be avoided and even the proximity of icebergs detected. Ships also can communicate with each other by underwater waves, sent out by oscillators.

"By means of a cable laid along the bottom of New York channel and energized with current, a pilot blindfolded, guided a destroyer safely to port, never getting more than fifty yards from the line of the cable. The waves sent out from the cable were detected in telephone receivers, one on each ear, telling him whether he was to right or left of the guiding cable.

"Hurricanes can be detected by sensitive radio telephones, and even the general direction of storms is now sent broadcast by coastal stations, and the time given for wireless receiving apparatus. By wireless methods the ship can tell its location. Weather warnings and location of wrecks, derelicts and icebergs are given out."

Articles to Appear in March Issue of "Radio News"

The Radio Station at Rome

A "B" Battery of the Edison Type
By W. H. Farr

A Practical Portable Receiver
By S. G. Cline

The Phantom and the Circuit
By C. O. Parks

Short Wave V T Transmitter and Regenerative Receiver with Two-Step Amplifier
By W. Hyndman, 1 A. T.

A Complete Radiofone Set
By Frederick J. Rumford

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New Danish Radio Invention

Two Danish Radio Engineers With Their New Radio Recording Apparatus Which Promises Much for Future Radio Developments. It Is Adapted to Record Either Radio Telegraphic or Telephonic Messages.

A new Danish invention in radio-telephony was presented at the recent Congress of Physical and Natural Sciences held in Copenhagen, Denmark. This invention is due to Messrs. Leck and Johnson, two radio engineers.

These inventors have perfected a system, it is said in cable reports, whereby it is possible to permanently record wireless telegraph or telephone messages. Radio-telegraphic signals have been recorded at high speed, by their newly devised instruments on a paper tape, similar to those found in district telegraph offices, and used in connection with a telegraph tape recorder, with which most of us are familiar.

Wireless telephone messages are recorded on a phonograph in a special and very effective manner which is said to be superior to that in use heretofore. In one of the experiments recently made, violin music was transmitted via radio-telephone and reproduced from the recording machine, perfected by Messrs. Leck and Johnson, and the music came forth in great sonority and purity.

These two Danish engineers, who bid fair to further the art of radio to a very large extent, are here shown with their new apparatus for recording radio-telegraphy and telephony communications.

The Edison Effect and the Audion

By DONALD McNICOL

In the litigation conducted during the past few years to determine the relative status as an invention of the De Forest audion and the Fleming valve, reference was made to the work along similar lines by Elster and Geitel in the year 1882, to Wehnelt's incandescent cathode rectifying tube of 1903, and to the Edison "effect" described in a paper presented to the American Institute of Electrical Engineers, New York, in 1884. In this paper diagrams were presented showing an incandescent lamp globe with regulation filament and in addition one or more insulated terminals sealed in the globe with the filament, the outside terminals of the latter connected thru a galvanometer to the source of current heating the filament. When the current was increased and the filament made highly incandescent the galvanometer indicated a considerable flow of current, notwithstanding that one of its terminals was connected only to an insulated wire or plate within the lamp bulb.

At the time of its discovery, and for many years thereafter, the effect observed was regarded merely as interesting phenomena. When, however, Fleming, in England, and De Forest, in the United States, in 1905-1906, developed their evacuated bulb detectors for electromagnetic waves, the early experiments of Edison were soon recalled.

It is a remarkable fact that in all of the search for priority the earliest work uncovered by the investigators was that of Elster and Geitel in 1882.

De Forest's patent No. 867,877; original

(*Continued on page* 1247)

Concerts Via Radiophone

Radio amateurs within a fifty mile radius of Philadelphia and some even farther away, have been enjoying evening concerts given by the Philadelphia Wireless School.

The accompanying photograph shows the powerful radio transmitter whereby the music is sent out broadcast from a talking machine. The phonograph is placed in front of the telephone transmitter or microphone of the radio set and one-half dozen records are played.

All the amateur radio operators even as far as New Brunswick, N. J., Wilmington, Del., and Baltimore, Md., have "listened in" and enjoyed the concerts.

Before the evening radio concert, which is destined to become quite *de rigeur*, the performance starts with a few jokes and with a summary of the day's news and the official weather report. Then the bank of audion tubes start whirling the electrons around and cut loose via the antenna atop of the school, with the latest thing in jazz music and syncopation.

Radio telephone concerts have or are about to take on a new aspect, especially for ships at sea, and in supplying music for other occasions. This is rapidly being brought about by the employment of powerful multiple stage audion amplifiers, whereby the received music is intensified so as to be heard in a room or hall.

The popularity of radio telephone concerts whether small amateur affairs in local circuits or whether large concerts such as that given a short time ago by Mme. Tetrazzini at New York to the U. S. sailors at sea, has rapidly increased as time goes on.

A Phonograph Is Placed in Front of the Telephone Transmitter and a Half Dozen Records Are Played. All the Amateur Operators—Even as Far as New Brunswick, New Jersey, Hear All the Latest Jazz Tunes Given in the Concert by the Philadelphia Wireless School. The Evening Concert Starts with a Few Jokes, a Summary of the Day's News and the Official Weather Report.

Photo (c) by Keystone

Who wouldn't rather listen to wireless telephone speeches than to code dots and dashes? Nothing is more exciting and interesting, especially to the members of the family.

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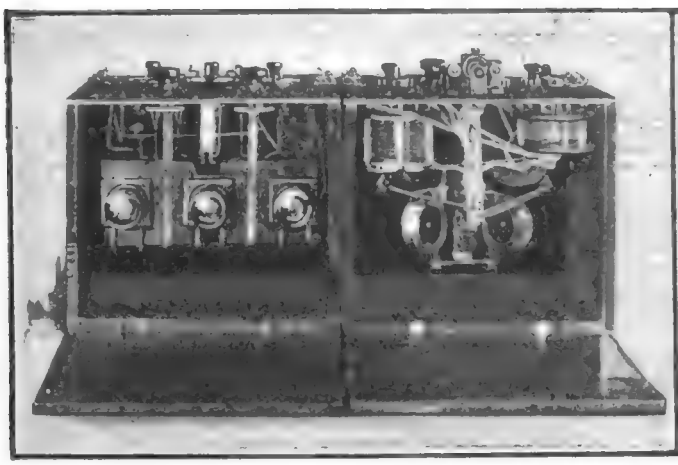
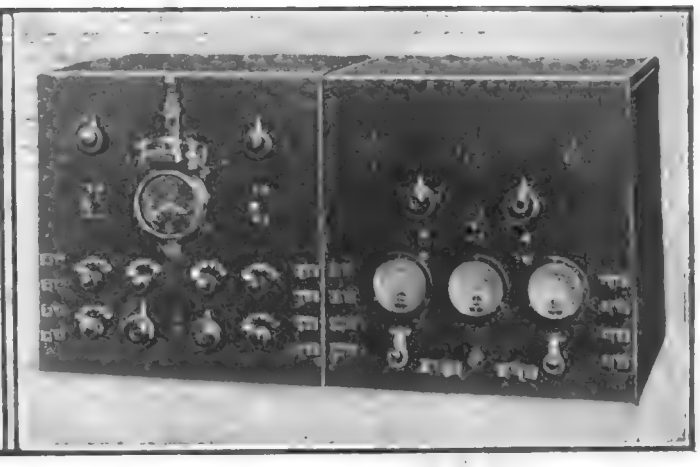
Building a 150 to 20,000 Meter Radio Receiver

By BERTRAM C. ROGERS



View of 150 to 20,000 Meter Radio Receiving Set Showing Interior Arrangement of Vacuum Bulbs, as Well as Honeycomb Coils and Variable Condensers.



Front Appearance of Two-Panel Receiving Set Employing Three Vacuum Tubes. The Set Comprises V. T. Detector and Two-Stage Amplifier, with Common Plate Battery.

THE accompanying photos and diagram with a few words of explanation are presented to the amateur who has wanted a long and short wave set complete in one cabinet which will not approach a "baby grand" in size. The panel is 12 inches by 12 inches, the cabinet being 10 inches deep. The detector and two-stage amplifier are of similar size in order to match up.

The outstanding features of this set that will appeal to the radio man desirous of building a universal set are the use of standard parts, maximum efficiency, simplicity of operation and permanency, the six honeycomb coils doing the work of the dozen and a half necessary in the usual coil-mounting set.

The antenna and ground are connected to the two lower left-hand clips, proceeding to the two centrally located switches. The diagram shows clearly the method of deadending the coil not in use. Coils are standard tapt Radisco honeycombs; the 325 turn coils will bring in anything up to and including "NAA." On a single eighty-foot wire sixty feet high and using very loose coupling and maximum regeneration, "NAA" is readable thruout the entire house. The 1200 turn coils have tuned in Arlington's arc set, which is around 5,000 meters and practically all of the longer wave stations operating, including the naval stations, Nauen, and a great many others whose signatures have not been obtained by the writer. The primary condenser is a .001 mfd. Murdock, but we would advise using a balanced type variable. The same holds true for the .0005 mfd. Murdock used for tuning the secondary circuit.

The right-hand key switch is connected so as to place the primary variable condenser in three positions—series, aperiodic and shunt—the aperiodic position being obtained by bending the antenna terminal of switch to make contact in the center position of key.

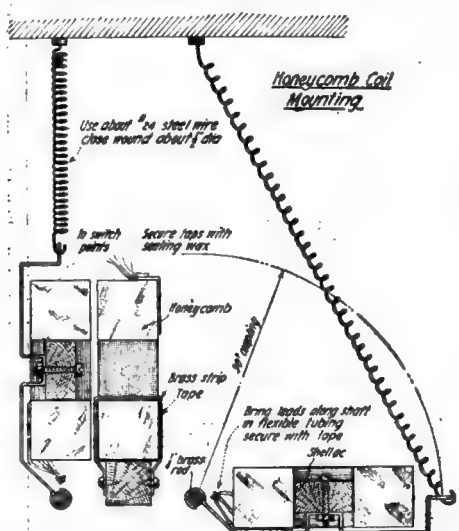
The eight-day clock is very conveniently adjusted occasionally by time signals and is used to record time only. This statement should not allow anyone to be misled into thinking that "tikker" reception is used as well as crystal and autodyne.

The crystal is ready for emergency use by placing phone tips in the two upper left-hand binding posts and adjusting the point, leaving it off the crystal, of course, when using the tubes. Thus it is not necessary to suspend operation because of a defective "B" battery, etc.

We now come to the coil mounting: The two fixt coils are strapt with thin sheet metal, extreme care being taken to insulate with tape and to use only sufficient pressure to hold the coils firmly; any excess will crush the coil and possibly short-circuit some turns. The movable coils are mounted by fastening maple centers to the coil with shellac. A rigid strip of brass is soldered to the shaft, which may be a one-fourth inch brass rod. Drill the other end of the strip and maple center for a one-inch brass machine screw and nut. An 8-32 or 6-32 screw will answer.

Taps should be brought out along the shafts of the moving coils, all leads and wiring should be spaced wherever possible and should positively be encased in good

(*Continued on page* 1245)



Detail Drawing Above Shows How Honeycomb Coils Are Mounted with Spring Controls, About a Central Axial System, Greatly Economizing on Space.

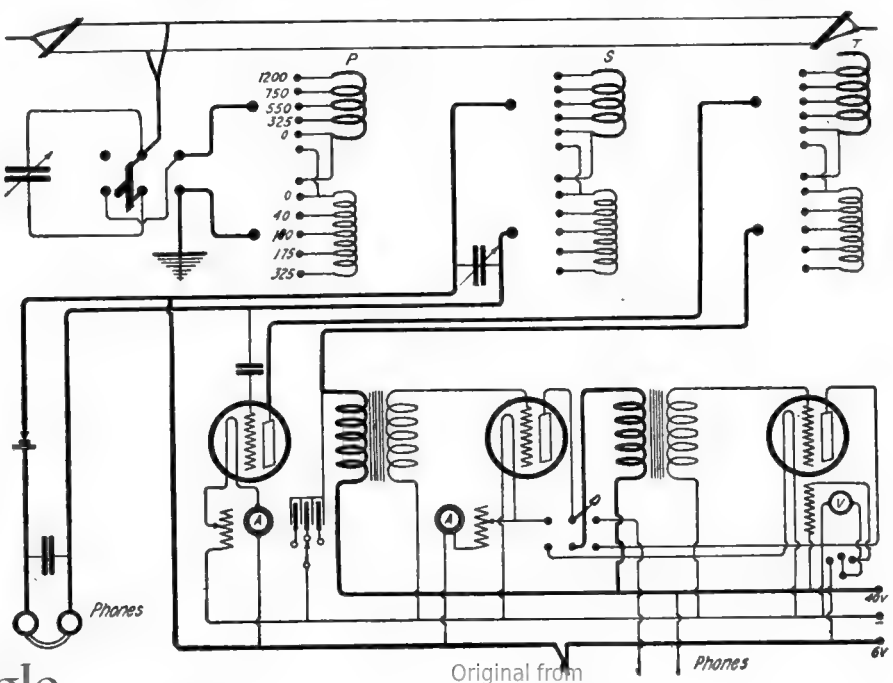


Diagram at Right Shows Disposition of Primary, Secondary and Tickler Windings, Designated "P," "S" and "T" Respectively. Battery Current and Potential Meters Are Provided.

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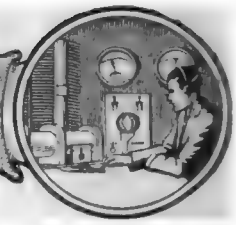
WITH the AMATEURS



Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest in this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $5.00 each month for the best photo or photos and $2.00 to each "Honorable Mention." Address the Editor, "With the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

This Month's $5.00 Prize Winner—E. H. Bitner

THE accompanying two photographs show my electrical and mechanical laboratory containing a lathe, Tesla coil, miscellaneous electric experimental apparatus such as spark coils, electric magnets, etc., as well as small steam engines which I have built myself.

The bench lathe is driven by an electric motor and was rigged up by myself, in the manner here shown. Part of my work-bench equipment includes a powerful hand-operated drill press and vise for holding the parts to be drilled. I have several electric motors of various sizes suitable for both battery and 110-volt service.

On the wall in the center of the first picture may be seen my switchboard by means of which various test circuits can be arranged as desired, giving different potentials for high or low-voltage resistance apparatus, as the case may be.

I have spent many pleasant evenings in my laboratory endeavoring to work out in practise, some of the interesting devices described in various text-books and magazines.

With the lathe, drill press and by the aid of a complete set of hand-tools which I keep in the drawer of the work bench, I find it possible to turn out some very creditable work indeed.

There is nothing so absorbing as experimental philosophy, especially when your experiments are successful, as mine usually are.—E. H. Bitner, 1510 Catherine Street, Harrisburg, Pa.

Honorable Mention—Harry Baird, $2.00 Prize

I HAVE recently taken the two accompanying photographs of my chemical and "Brownian Movement" laboratories, which, as you will see, are very interesting. The illustrations show clearly how carefully my materials are kept—each in its proper place. This arrangement is very practical and saves much time and trouble for me when I perform experiments.

The skeleton effect shown in one of the photos is an unusual one, and the position occupied by the spectre is the place where the experimenter would sit. The skeleton was painted in black on the negative and then printed in the usual manner.

In working with Brownian Movements, I have found that one of the best substances to demonstrate the motion of the minute particles with is colloidal suspension of resin. I prepared this mixture by dissolving a small particle of resin in 5 cubic centimeters (c.c.) of alcohol, and then diluting to 50 c.c. with water.—Harry Baird, 6436 Emerald Avenue, Chicago, Ill

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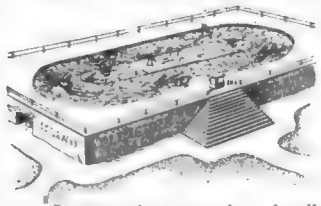
LATEST PATENTS

Sailing Amusement Device.

(No. 1,357,995 Issued to Alexander Kitterman.)

An amusement, that is a real amusement, is described in this pat-



ent. In operation, a series of sailing boats are caused to travel over a body of water on an elongated course and they tip to either side as the wind affects the sail areas. This apparatus consists of an endless flexible chain-like member that is carried along the elongated course submerged below the surface of the water; to it the sail boats are flexibly connected so that they can be propelled by wind power, which power is transmitted to the endless carrier or chain. On either side of this endless carrier and also submerged is a platform or guideway, which prevents the vessels from tipping over too far.

India Rubber Propeller.

(No. 1,360,596 Issued to Miles C. St. John.)

This is one of the cleverest devices in airplane propeller design which has yet come to our attention. Due to the increased scarcity of suitable wood for propellers, it has become necessary to construct them of some other material. The inventor here describes a propeller made of rubber suitably reinforced with fabric which is weatherproof and which is extremely light, being at the same time resilient. It is so

arranged that each blade is built as a clincher tire and can be removed. The hub contains valves so that the propeller can be inflated with air to a very high pressure, thereby adding to the strength and rigidity of the propeller construction. The tips of the blades are vulcanized to any degree of hardness and due to the inherent elasticity of the rubber and fabric construction, this propeller is much more able to resist shocks than the wooden type now in use.

Household Potato Peeler.

(No. 1,355,393, Issued to Anselm De Ghetto.)

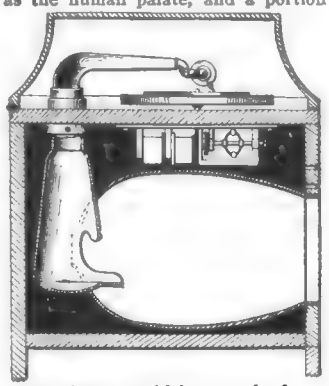
This is a nice little household article which every woman will appreciate. It is an improved and economical potato peeler, in which

a steel conical shaped wire frame is used to scrape off the peel and therefore less waste results. It consists of a wooden core covered with a steel wire frame, the wires of which are inserted in a fabric strip screwed to the cone.

Phonographic Amplifier.

(No. 1,360,577 Issued to William Edward Pugsley.)

The inventor of this device has gone back to the olden days when musical instruments and telephones were made to resemble the appendages and organs of the human being, and he claims that his device is acoustically perfect. The system consists of a conduit leading from the reproducer of a phonograph constructed and shaped to approximate the human throat as much as possible. This is called the "throat." It opens into a large amplifier chamber resembling the mouth of the human being, thru the agency of a peculiar irregular opening. The top of this opening is such that it forms a depending portion, which the inventor terms the "palate," because it is shaped as the human palate, and a portion

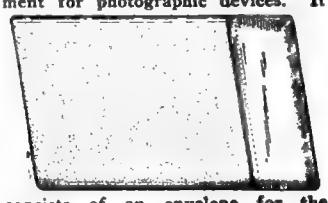


at the bottom which extends for a considerable distance is termed the "tongue." A means for bringing about the circulation of air is also embodied in the claims. Almost half a century ago the telephones were made to resemble human organs such as the ear and mouth. This style has been found to be non-essential for accurate reproduction, and we are just wondering how this particular device will fare.

Photographic Envelope.

(No. 1,360,624 Issued to William L. Dodge.)

This is a rather novel arrangement for photographic devices. It

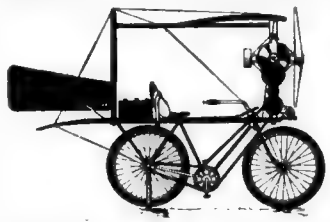


consists of an envelope for the reception of exposed photographic film which has embodied therein the developing chemicals or the combination developing and fixing chemicals, whereupon by simply soaking the envelope in a water bath, the resulting film will be both fully developed and fixt. This action may be carried on in daylight. The envelope must of course be used in cameras where the film may be removed and inserted into the envelope without coming in contact with the light. Therefore, the above operation may be completed without fear of spoiling the negative. Arrangement is also made so that the envelope itself will be composed of absorbent material sufficiently saturated with the necessary chemicals for developing and fixing.

Airplane.

(No. 1,355,315 Issued to Albert Covello.)

This machine consists essentially of a frame-work resembling a bicycle with the exception of the fact that an extra chain is connected from the sprocket to a propeller, thru a coaster brake; also connected to this propeller are two

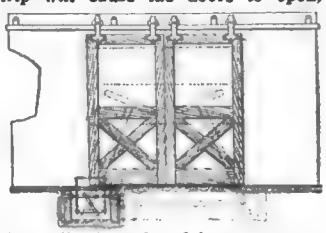


handles which serve to drive it should the operator's feet become tired or should more power be desired. Upon the super-structure placed upon this bicycle a large airfoil is fastened and at the rear elevating and steering rudders are pivoted. So far the flying range of such a machine has remained somewhere around forty feet.

Garage Door Opener.

(No. 360,479 Issued to Robert M. Wallace and Edward J. Scott.)

The device consists of two "T" shaped levers connected together at the lower ends by means of a link, so that both will move at the same time; the upper portion of each "T" is heavily leaded so as to constitute the weight in order that when the levers are slightly off the vertical, the weights will cause them to swing over due to gravitational pull and cause the door to either open or close, depending upon the direction they are falling. A crank or automatic trip is fastened into the driveway, so that the front wheels of a car passing over the trip will cause the doors to open,

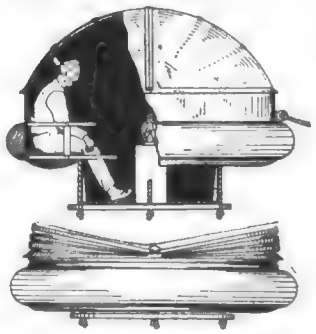


thus allowing the driver to enter the garage without stepping from the machine to open the door.

Life Saving Apparatus.

(No. 1,360,755 Issued to Harold Jordan.)

This apparatus consists mainly of a large, light buoy, the inner edge of which is formed as a seat for a number of persons. Its central opening is covered by a collapsible watertight bag having a rigid bottom. The buoy ship body is provided with a collapsible frame-work of ribs covered by a water-tight fabric. The



entire device is collapsible and therefore occupies very little space when in a vessel.

Visible Guide for Vessels.

(No. 1,357,976 Issued to John Hays Hammond, Jr.)

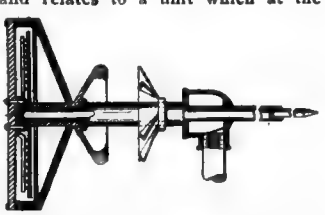
This is another issue to the well-known American authority on radio-control and deals with visible guides for torpedoes and torpedo boats and other vessels operated from a distance either by wire or by radio. A light is stationed in a tower containing vari-colored glass windows turning with the vessel and a reflector placed partly around this light and moving with it, not the vessel. The torpedo when started will have its light projected toward the transmitting station and should it swerve from this course, a different color window will be visible, due to the fact that the color screens turn with the vessel while the light proper is connected

directly to a gyroscope, which keeps the light ray directed toward the shore regardless of the direction taken by the torpedo. A compass may also be used to control the light in place of the gyroscope.

Apparatus for Electrically Charging Fluids.

(No. 1,360,665 Issued to Edgar Earl Littlefield.)

This is a rather clever invention and relates to a unit which at the



same time both charges water with electricity and sprays it upon various objects such as plants and other vegetation. The inventor has found that beneficial results are obtained when plants and vegetation are sprayed with chemicals dissolved in water and also with electrically charged liquids; the fungi and other insect pests are removed and destroyed thru this action. Essentially it consists of a device resembling a water motor, which in turn rotates the armature of a generator, or in another form the rotors of a static machine. Brushes collect the current so formed and charge the water streams either by induction or by direct contact thru the nozzle. Provision is made so that one terminal can be grounded if desired, in which event the ground acts as one pole and the stream, or streams, the other.

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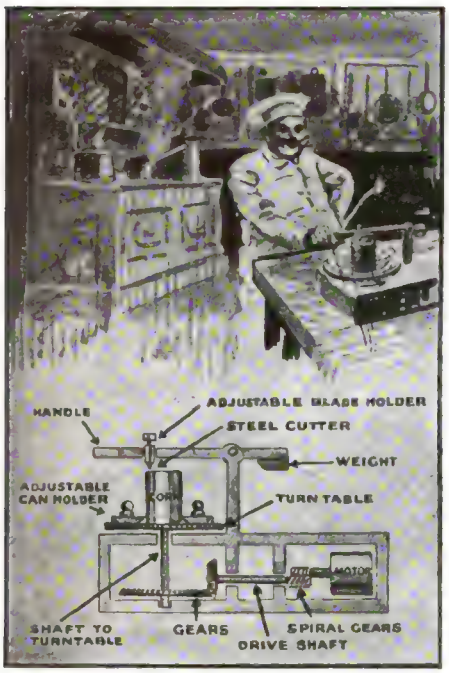
What To Invent

By JAY G. HOBSON

Renewable Electric Light Bulb

SOME statistician has figured out the enormous loss to electric light users from the burning out of the delicate wire filament which is the heart of the light. Oftentimes it happens that the slightest jar snaps the vital thread, making the light bulb dead—



Why Not an Electric Can-Opener for the Restaurant and Sampling Room? Hundreds of Cans Can Be Opened Hourly with Such a Motor-Driven Device.

of no further use whatever. If I remember correctly, the stupendous sum ran into ten or fifteen million good, American dollars, yearly. At any rate the amount of loss suffered, throwing away broken electric light bulbs after a little use, impress me with the great need of an improvement along this line.

An improvement capable of saving only one-tenth of the total loss would be a wonderful achievement with instant success. But I will admit the accomplishment is not as easy as the suggestion; however, the idea recorded here may start someone on the worthy task with a successful solution as the result.

Recently an inventor patented an improved electric light embracing two filaments, to give double duty; in fact it was two lights in one and may prove of some merit; but I doubt if the solution rests in combining two delicate constructions of equal durability, because both are liable to break simultaneously if the one can break singly. The logical plan of experimenting for an improvement of this kind would be in an adjustable and removable filament, one that could be replaced in the glass bulb without losing the proper condition inside required for brilliant illumination. The large electric light companies certainly would bid eagerly for this improvement, and needless to say the inventor would profit in a handsome manner.

Electric Can-Opener

In wholesale grocery, fruit and canning plants hundreds of canned foods are opened daily by the old hand method which is not only slow and botchy, but often disastrous to the fingers of the operator. The purpose of opening large quantities of canned goods is to examine the edibility of same and allow buyers to sample the different brands offered for sale.

An improvement in can-openers undoubtedly would meet with hearty acceptance and soon become a large commercial success because of its speed and saving in both time and the hands. An electric opener constructed along the line of the accompanying illustration, having the cutting element adjustable to different size cans and operated from a small motor properly geared for lending sufficient power to the cutter to open the hardest tin. Every wholesale grocery house in existence would immediately appreciate an invention of this nature when presented to them. The machine must be practical and sell within reason having regard to the cost of its operation and ownership.

Four-Edge Safety Razor Blade

Now, boys, here's a gem of an improvement we close observers have completely failed to recognize. Just think how wasteful and extravagant we have been throwing away our perfectly good razor blades after using only two edges of it, when we could have obtained twice the number of shaves had there been four edges instead of two.

And when you stop to consider, the "Square Four-Edge Safety Razor" is entirely practical, yes, decidedly economical, you must admit there's merit in the idea. The tons of steel blades going to waste each year, from the hands of the shavers, who usually discard them when dull, would furnish enough steel to build several sky-scrapers along our busy streets.

It is reasonable to believe that four edges could be given to a square blade as easily as two edges now accepted as standard. But in reality nothing is standard for conditions and requirements are changing so rapidly; what is called standard today may be one of the antiquities tomorrow as evidenced by the first horseless carriage and that wind-

A Four-Sided Safety Razor Blade Should Prove a Boon to Mankind. Four Sharp Edges Are Available Instead of the Usual Two or One Now Supplied.

And Speaking of Finger Nail Clippers, Why Doesn't Someone Give Us a "Real" Clipper That Will Not Mangle the Nails and Which the User Can Manipulate Equally Well with Either Hand?

splitting demon of today—the airplane. So four-edge safety razor blades are within the bounds of possibilities for tomorrow; and may some agreeing colleague inventor bring one of this kind out soon, as I am always running out of sharp blades and can use the four-square beautifully.

Improved Finger Nail Clipper

Now that the dear women have the vote, are citizens and can become just as notorious in politics as the worst politician, if desired, I expect to see considerable activity in the ranks of women inventors, as there should be. But ever since our sinful ancestors moved from the Garden of Eden men have been inventing new conveniences for women, and the women have neglected their pals by not reciprocating. Here is the chance they have been looking for to get even; an improved nail clipper for men is badly needed. There are nail clippers and nail clippers on the market, but none that I have ever seen are entirely what is desired for the masculine manicure. Those offered for sale simply pinch the nail off instead of cutting it, which would be more satisfactory. Why not design a clipper with the scissor movement and action so that the nail would be easily and evenly cut instead of pincht off unevenly as with the present kind.

I am sure there is only one man out of a thousand who can use the scissors on his right hand.

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Scientific Humor

Ours Says "Stillbusy."—A suburban housewife relates overhearing this conversation between her new maid and the cook next door:

"How are you, Hilda?"

"I'm vell," said Hilda. "I like my yob. We got cremated cellar, cemetary plumbing, elastic lights and a hoosit."

"What's a hoosit, Hilda?" the puzzled cook exclaimed.

"O, a bell rings. You put a thing to your ear and say, 'Hello' and someone says, 'Hello,' and you say, 'Hoosit.'"

—Creston Hutchinson.

Paid Attention.—"I can't stand the tension," sighed the convict as the electric chair ended his earthly sorrows.

—Ross Brearty.

Alchemy.—In the little town of Beulah, New Mexico where it is a rare occurrence to see a white woman, two men, Stone and Wood, were standing on the sidewalk, when a well drest young lady came tripping down the street. Wood turned to Stone, and Stone turned to Wood, and as she past they both turned to *rubber.*

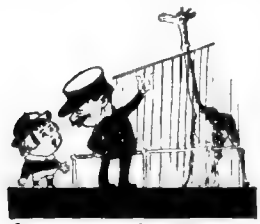
—S. L. Barker.

And Then "Pat-Ended."—An Irishman stood looking at an electrical contrivance, when an inventor walked over to him and asked, "Some machine; I wonder who the inventor is?"

The Irishman looked at him and replied: "Shure it was a son o' the Sod. Can't you see his name there.—'Pat. Pending.'"*—J. J. Beaty.*

Applied Chemistry.—Chemistry Professor: "What happens to gold when it is exposed to the air?"

Student (after long reflection): "It is stolen."*—Albert Schilling.*



Zoo-Logical.—"And you give the giraffe only one lump of sugar?" asked the little boy at the zoo.

"Oh, yes," replied the keeper. "One lump goes a long way with him."

—Frank W. Shannon.

A Scientific Postmaster.— A postmaster received a letter in the mail and it was addressed thus:

Wood
a
Mass.

He finally puzzled it out thus:

A. Underwood
Andover
Mass.

—John Fenling.

Did They Keep Time?—"In a recent flood in the Mississippi a man was seen riding down the river on a big bass violin. When he was rescued from his perch he was asked if his wife had escaped. "Yes," he answered, "she accompanied me on the piano."*—Carl A. Fanton.*

FIRST PRIZE $3.00

Cold Facts.—Teacher: "When two bodies come together violently they generate heat."

Pupil: "Not always. I hit a guy once and he knocked me cold."

—S. W. Coleman.

He Must Have Been Hoarse!—"Say, did you know that Jiggs was choked to death up in the restaurant this morning?"

"No, how did it happen?"

"He was eating some horse meat and when a piece got half way down someone hollered 'WHOA'!"*—No Name, Kirkville, Mo.*

Perpetual Motion.—Salesman: "This machine will do the work of three maids."

Mrs. Knicker: "I want one to do the work of 30, we have that many a month."

—Frank Mirolli.

We receive daily from one to two hundred contributions to this department. Of these only one or two are available. We desire to publish only scientific humor and all contributions should be original if possible. Do not copy jokes from old books or other publications as they have little or no chance here. By scientific humor we mean only such jokes as contain something of a scientific nature. Note our prize winners. Write each joke on a separate sheet and sign your name and address to it. Write only on one side of sheet. No letters acknowledged unless postage is included.

All jokes publisht here are paid for at the rate of one dollar each, besides the first prize of three dollars for the best joke submitted each month. In the event that two people send in the same joke so as to "tie" for the prize, then the sum of three dollars in cash will be paid to each one.

Where Ignorance is Bliss.—Bud: "Well, Jim, I see you are instructing Ed Simmons to become an aviator."

Dick: "Yes, I have taught him everything I know and he's still an ignorant fool."*—William Tuman.*

Some "Boner."—Instructor: "What is all that noise I hear in the biology laboratory?"

Student: "That's the biology students rolling the bones."*—No Name.*

Why Not Wireless.—Dubb: "Where do you live in the city—close by?"

Stubb: "Fairly so — thirty minutes on foot, fifteen by motor car, twenty-five by street car, and forty-five by telephone."*—No Name.*

Yes, While the Blonde Took Peroxide and Dyed!—An exchange says that a man who had been dumb for years picked up a *hub and spoke.* That's nothing! A blind carpenter reached out for his *plane and saw;* a deaf ranchman went out with his *dog and herd;* a noseless fisherman caught a *herring and smelt;* a defunct hatter was tenderly deposited on a pile of *hair and felt;* and an elephant inserted his trunk in a *grate and flue.*

—H. E. Zimmerman.

Was the Spring Wound Up?—Mrs. Jones: "The butcher said it was a tender spring lamb."

Mr. Jones: "He is right. I've been chewing one of the springs for the last half hour."*—Old Red.*

"Star-Tling."—Browne: "Her teeth are like the stars in the heavens."

Greene: "Why?"

Browne: "They come out every night."

—M. Zimmer.

Watch-Ful.—Sharks: "The other day my watch stopt, and when I took it to the jeweler he found a tiny bedbug in it."

Sparks: "That so? How did it get in?"

Sharks: "Why, it crawled in between the 'ticks'."*—Perry D. Wilson.*

Logic Arithmetic.—Arc: "If 2 in 1 is shoe polish and 3 in 1 is oil, what is 4 and 1?"

Spark: "I don't know."

Arc: "Five!"*—Lawrence Arthur.*

'Way Down South.—*News item:* "The 8 year old son of Mr. and Mrs. Silas Parker was struck by a falling electric cable and badly burnt on the South Side."

—H. B. Conant.

Forewarned Is Forearmed.—"Your honor," said the lawyer. "I submit that my client did not break into the house at all. He found the parlor window open, inserted his right arm, and removed a few trifling articles. Now, my client's arm is not himself, and I fail to see how you can punish my client for an offense commited only by one of his limbs."

"That argument," said the Judge, "is very well put. Following it logically, I sentence the prisoner's arm to one year's imprisonment. He can accompany it or not, just as he chooses."

Whereupon the prisoner calmly unscrewed his cork arm and walked out.

—Raymond H. Klumpp.

That's Why He Was Sick!—Physician: "I'm sorry sir, but we can't quite be sure as to what is wrong with your arterial system unless we put you under the X-ray."

Publisher: "That's all right. I never made any secret of my circulation."

—E. McEvoy.

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THE ORACLE

The "Oracle" is for the sole benefit of all scientific experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions address to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

Radio Questions

(1080) F. L. Arnot, North Sydney, N. S. W., Australia, asks several radio queries.

A. 1. We cannot give you very much encouragement on the use of a crystal detector with underground receiving systems. The audion for wireless reception with the underground and loop antennæ systems is the best scheme.

For reception of high power European stations you should have an aerial about 600 feet long, single wire, or more if possible. Two loading coils, three feet long, and about five and a quarter inches in diameter, wound with No. 28 single cotton covered wire will answer for the inductance, and added to this of course the rest of the outfit. Inasmuch as most of the stations use undampt waves, you will have to employ a detector for undampt wave reception—i. e., an audion or other vacuum valve capable of oscillating or else a Poulsen tikker.

Since we do not know the English laws pertaining to radio as they stand at present, we are not in a position to advise you as to whether or not you could erect your receiving station and receive without a license. Consult your local government officials; the Post Office authorities should know about such matters.

Crystal detectors have been known to receive about 4,000 miles under favorable conditions. This is not by any means the record, nor are we in a position to post you as to what the actual record of crystal reception is. One or two variable condensers, a good three slide tuning coil and a vacuum valve detector together with the necessary loading inductance will enable you to attain a very good range indeed.

Are "Spigot and Pipe Line Motors" Practical?

(1081) Joseph Pacyk, Glassport, Pa., inquires:

Q. 1. Having read the illustrated article on the workings of a device invented by a French scientist which is a water turbine attached to a house water main which would produce electricity without cost, such as described in the January issue of SCIENCE AND INVENTION, on page 962, I wish to ask how this device can be practically a saving proposition in the cost of producing electricity.

Since the turbine gets its power from the pressure of the water, then where does the water get its power for nothing? For instance, if every house would harness one of these devices to their water lines, then there would not be enough pressure to go around. If the water is forced at stations by pumping methods, then if all houses would have the device installed, I believe that the pumping stations would require extra power to force the water thru the mains, since the small turbines in each house would take up a large amount of this water energy.

A. 1. With regard to the electric power from water spigot or conduit. This idea is intended to be carried out on a small scale, of course, and not by loading the house water mains with a large turbine so as to exert any noticeable loss in pressure on the system, which would be affected in the manner you state, if such were the case.

M. Colardeau's scheme is feasible if a small water motor or turbine is used to drive a small dynamo so as to charge a storage battery gradually by small increments of energy. This is the whole secret of the Colardeau scheme.

Furthermore, in many cases there is a far greater pressure than that required in many houses and in places where highly elevated reservoirs are used.

Action of the Scott Transformer

(1082) James Thompson, Troy, N. Y., asks:

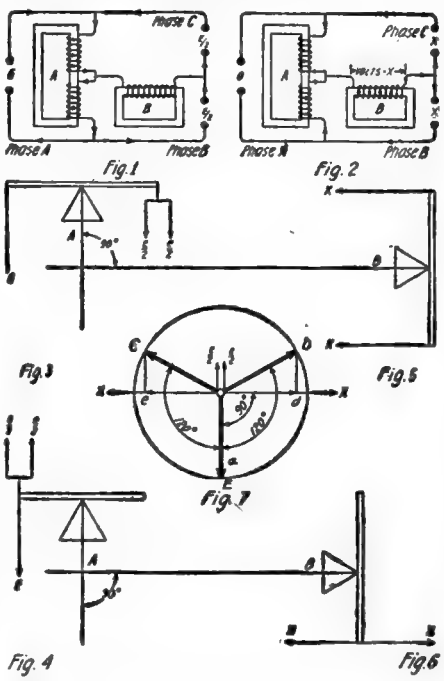
Q. 1. Can you solve for me the development of the three phases in a Scott transformer by the theory of forces.

A. 1. Figs. 1 and 2 represent the secondary windings of transformers A and B connected to a two phase circuit. When the secondary pressure of transformer A equals E, we are to find the secondary pressure of transformer B in terms of E, that will produce three equal phases, 120 electrical degrees apart and each equal to E.

Fig. 1 represents the condition when only transformer A is excited. There is no magnetic flux in transformer B, therefore no current is flowing through the secondary windings. The pressure in phase A equals E, while in each phase of "b" and "c" the pressure equals $\frac{E}{2}$ and in the same direction.

Fig. 3 is a diagram of these forces which are in equilibrium, while Fig. 4 represents Fig. 3 with the forces transposed.

Fig. 2 represents the condition when only transformer B is excited. The resultant magnetic flux in transformer A is zero, due to equal opposing currents as shown. The pressure in phase "a" equals zero, while in each phase of "b" and "c" it is equal to X (unknown).



Diagrams Used in Explaining the Action of the "Scott" Transformer by the Theory of Forces.

Figs. 5 and 6 are diagrams of these forces 90° relative to those of Figs. 3 and 4.

By combining the forces of Figs. 4 and 6 we will have the composite primary action of transformers A and B, as shown in Fig. 7.

With a radius equal to E construct a circle.

Draw lines *o b* and *o c* at an angle to *o a* equal 120°, to represent phases *o b* and *o c*. Perpendiculars through *b* and *c* to X, X intercept at points *d* and *e*.

Then *o d* and *o e* are the pressure components of phases *b* and *c* due to transformer B.

The resultant of the two right angular forces E/2 and o d equals o b. Therefore o d equals $\sqrt{E^2-(E/2)^2}=\frac{\sqrt{3}E^2}{2}$ which is the voltage of the secondary of transformer B. We have proved by the theory of forces that to transform with a Scott connection a two phase current into a balanced three phase, the voltage of the secondaries of the two transformers must be as E is to $\frac{\sqrt{3}}{2}$ E.

Answer by Russel E. Taylor.

Storage Battery Plate Filler

(1083) B. F. Walburg, Toledo, Ohio, asks for any storage battery plate filler.

A. 1. An oxide of lead is generally used in these batteries. It is applied to the grid in the form of a paste as either litharge, Pb 0, or red lead, $Pb_3 0_4$, and then substances may be added for one or more of the following purposes: to increase the hardness, porosity, toughness or conductivity. They may include glycerine, graphite, potassium silicate, and ammonium sulphate. These are then *formed* by being placed in a bath of dilute sulfuric acid with *dummy* lead plates for the opposite electrodes. A *forming* charge is now past thru, followed by a discharge with frequent repetition.

Negative plates are formed by passing a current thru in the opposite direction, reducing the lead oxide to spongy lead and converting the positive electrode to lead peroxide. After *forming*, the plates are dried and are ready for the market.

The proportions depend entirely on the plate manufactured by the different companies, and which are about nine parts of the lead oxide to about one part of the additional substances. This, however would depend entirely on the quality of the mixture, etc. In the case of glycerine just enough is added to form a nice thick paste.

Radio Condenser Specification

(1084) Wesley T. Meyers, Milwaukee, Wis., writes the Oracle:

Q. 1. For size of condenser to be used with ½ K. W. open core transformer.

A. 1. For a ½ K. W. open core transformer set the secondary condenser capacity should be about .08 microfarad. This will require eight 5x7 inch photographic plates, covered to within 1 inch of each edge with tin foil. This gives about 120 inches of tin foil, the inductivity factor of the glass being here taken as 3.13 in order to ascertain what the approximate capacity would be.

Keeping your wave length within 200 meters will depend largely on the size of your aerial. Altho we do not recommend hooking up the condenser in series with the ground, such procedure would cut down your wave length considerably.

Bichlorid of Mercury Tablets

(1085) Rex Towgood, Sandon, B. C., asks about a patent on changing form of bichlorid tablets:

A. 1. Bichlorid of mercury tablets at the present day do not at all resemble Aspirin tablets. In New York City it is against the law to sell bichlorid except under physician's prescription. Then the tablets may be obtained only in the following forms: One, in the form of triangles (note the resemblance to your invention). These tablets are contained in triangular bottles which are incidentally covered with minute glass embossments. The rough surface of the bottle thus formed will warn any one attempting to take them by mistake. Furthermore, the bichlorid tablets are colored blue with some inert innocuous substance.

There is another form on the market which comes in a casket shaped bottle. The tablets likewise are casket shaped, colored and an embost poison mark upon them. No such tablets would be mistaken for Aspirin tablets, which as you know are round. Accordingly we believe that it would be useless for you to obtain a patent on either of these two forms of bichlorid tablets.

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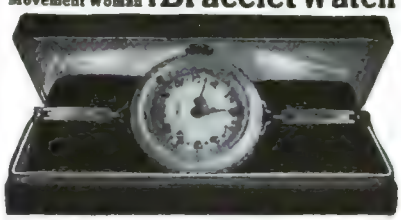

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12 size, octagon, open face, gold plated case, plain polished with triangular bow and jeweled crown. Has a genuine 7-jewel Swiss movement, full nickel, lever escapement, exposed winding wheels, gold dial. A big bargain in a high grade Swiss watch. Just send your name and address and back will come the watch, postage paid. Order by No. D215. Pay postman the low special price $7.35

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Dept. D., Box 826 Chicago, Illinois

Popular Astronomy

By ISABEL M. LEWIS, M.A.

(*Continued from page* 1183)

volume, yet of a density so small that its surface gravity is not more than *one hundredth* of the value of gravity at the earth's surface. An object weighing two hundred pounds at the earth's surface, and two and a half tons at the surface of the sun, would weigh only about two pounds at the surface of the star Betelgeuse.

Almost simultaneously with the determination of the angular diameter of this star at the Mt. Wilson Observatory by means of the Michelson interferometer, there appeared in an astronomical publication a paper upon "The Probable Diameter of the Stars," by Prof. H. N. Russell, in which the diameters of a number of stars, including Betelgeuse, were found from determination of the relative surface brightnesses of the various types of stars depending upon observations of the relative amounts of red and blue light in a star's spectrum, or its "color index," which is now known for a great number of stars. It is of particular interest at this time to know that the angular diameter of Betelgeuse determined by this method, thirty-one thousandths (".031) of a second of arc, agrees closely with the value determined by direct measurement with the Michelson interferometer. Two men attacking this problem of the diameters of the stars by two entirely different methods, one observational, the other theoretical, obtain almost identically the same value.

From these published results of Russell's investigation, it appears, as has been suspected for some time, that the deep red stars of certain types are the stars that have the greatest diameters.

In seeking out stars with large angular diameters upon which to test the new interferometer method, then, the astronomer turns to the red stars, since among them he finds the giants of the universe with angular diameters exceeding one hundredth of a second of arc. Antares, in Scorpio, the conspicuous red star visible in the southern sky in summer evenings, is another red giant that, according to Russell's computations, has an angular diameter of nearly three hundredths of a second and an actual diameter of over two hundred and fifty million miles. It is, therefore, a close rival of Betelgeuse in size. Stars of no mean size, tho far inferior to the two just mentioned, are Aldebaran and Arcturus, familiar first magnitude stars which according to the computations have diameters of twenty million and twelve million miles respectively.

A most remarkable star noted in Russell's paper is a deep red, variable star, known in star catalogues as VX Andromedæ. For this star the computed angular diameter is five hundredths of a second, which is the greatest angular diameter found for any star in the sky. Since this star is not a near neighbor of the solar system, such an angular diameter must represent a diameter for this star comparable to that of the solar system itself. Of course the values given for the diameters of the stars by this method are considered only as rough estimates, but they at least indicate that the red giant stars surpass all others in actual size, and that compared to them our own sun is a dwarf.

For one of these dwarf stars whose distance from the earth is not great, a density four times that of the sun and a diameter of only three hundred and sixty thousand miles was found by this method.

(*Continued on page* 1218)

Pearl La Sage Cold Cream

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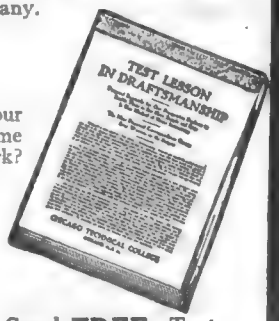

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Popular Astronomy

(*Continued from page* 1216)

What extremes, then, exist among the stars of the universe! On one hand, there is the giant red Betelgeuse of nebulous density, and on the other the red dwarf of a density as great as our own planet earth, shining as a tiny sun, with a diameter less than half of the sun, and resembling in some respects a huge planet more than a sun. Surface gravity on this star is one and two-thirds that of our own sun and about forty-six times the surface gravity of the earth. An object that weighs two hundred pounds on the earth, about two pounds on Betelgeuse, and two and a half tons on the sun, would weigh over *four tons* on this dwarf sun.

Sirius, the most brilliant star in the sky, belonging to the class of extremely hot, white, hydrogen stars, has, according to Russell, an angular diameter of only seven thousandths of a second of arc, which at its distance from the earth of only eight and four-tenths light years, corresponds to an actual diameter of only one and a half million miles.

Rigel, the brilliant bluish-white helium star diagonally opposite Betelgeuse in the constellation of Orion, considered by some to be a super-giant of the universe, has a diameter of forty million miles if we accept the latest determination of its distance, which places it six hundred and fifty light years away. It is, therefore, far inferior in actual size to the red giants, Betelgeuse and Antares, tho it is a much denser and hotter body than these huge suns.

It appears now as if the diameters of these brilliant and tremendously hot white stars are on the average only *one-tenth as great* as the diameters of the red giants, and therefore that they are only one-thousandth as large. Enormous as the brilliant Rigel is in comparison to the sun (it would take one hundred and twenty-five thousand suns the size of ours to equal Rigel in size) compared to Betelgeuse it is quite an insignificant body, for *over four hundred* such stars as Rigel would be needed to make up the mighty bulk of Betelgeuse.

The Movie Theater of the Future

By H. GERNSBACK

(*Continued from page* 1173)

the repair has been made, so all the films will always run absolutely in step. There is no technical difficulty in doing this stunt, and it will be understood that inasmuch as the projectors are "behind" the screen, the films must be reversed or turned over, as otherwise the lettering, for instance, will read backwards as in a mirror. For this reason no special film is needed for a scheme of this kind.

After the screen and projecting arrangement has been lowered, a revolving stage, which the writer proposes, is unmasked as shown in our right-hand illustration. The space that was occupied by the projectors now is occupied by the raised platform on which an orchestra with the conductor is placed. Of course, this stage does not revolve very fast when the orchestra is sitting upon it; with just speed enough to make it interesting. The idea of the revolving stage is that the audience may see the conductor from all angles.

(*Continued on page* 1220)

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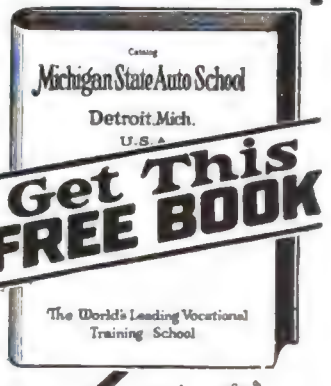

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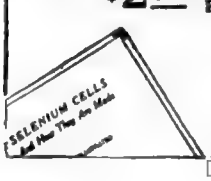

The Movie Theater of the Future

(*Continued from page* 1218)

which is not possible at the present time where a conductor always turns his back to the audience; this is often commented upon. Such a revolving stage, if necessary, can be used for many different subjects and various ideas suggest themselves immediately. By revolving the stage at a greater speed, trick bicycle performers or roller skate performers will be able to give some new thrills to the audience. A ballet performed by dancers will also present various new aspects on a revolving stage, as can be readily imagined.

Violin or piano performers may play readily on a revolving stage of this kind, and thus everyone in the audience will be able to watch the performer, not only by viewing his back but by seeing his face as well at times.

As a theater of this kind is rather large, the sounds naturally would be weak at the rear of the house, and for this reason the well-known electromagnetic loud-talkers are used thruout the audiences as shown. Thus, anything going on on the stage, such as music or talk, etc., will be heard loudly at any part of the auditorium.

How Rotogravure Pictures Are Made

By OSWALD R. SCHULTZ

(*Continued from page* 1197)

anism. To be certain that all pictures which are placed in such a large frame have good contact, a vacuum pump is connected by a flexible hose with a rubber blanket. This air pump sucks out the air which is between the form and blanket. In this way it guarantees good contact between the picture form and carbon paper. Powerful arc lights are turned on and given a certain length of time exposure, which operation is also called *printing*. Fig. 3. The carbon tissue with the printed pictures on it, is now put in another vacuum printing frame and placed on top of an engraved glass screen of from 150 to 175 lines to the inch, and given a second exposure. The tissue, which is really a paper, resembling "Solio" photo print stock, is now ready to be transferred to the copper cylinder.

The cylinders can be solid copper rolls or, better, hollow copper cylinders, slightly tapered on the inside so that they can be forced on a mandrel. Some are steel tubes on which a shell of copper has been deposited by electrolysis. Fig. 4. These rolls are polished and turned absolutely true in a lathe before they reach the carbon transfer room. See Fig. 5.

Transferring Picture to Copper Cylinder

To transfer the printed carbon tissue to the *copper cylinder*, it is soaked in a solution of alcohol and water. When the tissue begins to flatten, it is quickly lifted out of the solution, adjusted to the position indicated by pencil marks which have been drawn on the cylinders and squeegeed securely to it. All the water possible is prest out and all surplus moisture is wiped from the back with a soft cloth.

(*Continued on page* 1222)

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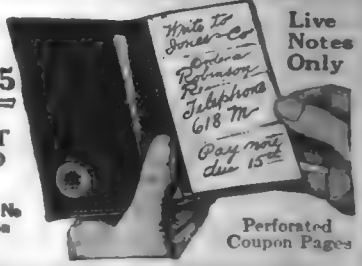

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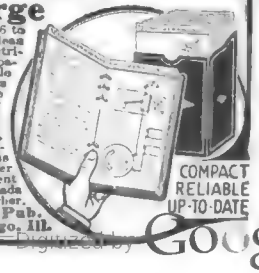

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How Rotogravure Pictures Are Made

(*Continued from page* 1220)

The roll is allowed to set for at least twenty minutes, while the trough is cleaned and prepared with hot water. When ready it is steadily turned over the developing trough until the paper backing is loosened and finally stript off. The soluble gelatin can be washed away until the image shows proper development. The image will be found on the cylinder in gelatin relief corresponding to the lights and shades of the positive, thru which the light entered. Where the positive is densest the light penetrated least and the film of gelatin is consequently thinnest. Where the positive was most transparent, the light acted to the greatest extent and the carbon film is thickest. The tissue is then treated with alcohol and water, gradually increasing the alcohol until pure alcohol is used to drive out all the water possible from the film to accelerate and ensure its drying.

It is now ready to have the margins covered with asphalt varnish to prevent the acid from etching them, and when perfectly dry the cylinder is ready for etching. Fig. 6.

Perchloride of iron of different strengths is the mordant used. The iron solution penetrates the thinnest parts of the *gelatin resist* first and therefore etches the cylinder most under these parts. Where the gelatin resist is thickest, corresponding with the high light of the positive, the mordant has the least effect on the copper and the etching is slightest. The important point to observe is that the screen lines are not etched away, for on the preservation of these lines as partitions between ink cavities and as bearers for the metal wiper, commonly called "doctor," the whole success of rotogravure printing depends.

After cleaning the asphalt protection from the roller with kerosene and removing the gelatin resist with a solution of acetic acid and water the cylinder is ready for the press.

The press (Fig. 7) which receives these copper cylinders is constructed in the usual method to allow the cylinder to revolve in a fountain filled with specially prepared ink. Since the design is etched below the surface this ink fills the design. By scraping all superfluous ink off the outside of the copper cylinder with the aforementioned "doctor" blade, the surface of the cylinder is kept perfectly clean and with the assistance of the rubber-covered roller or impression cylinder, the design from the copper cylinder is transferred to the web of paper when it passes between the rubber impression roller and the copper cylinder. As the inks are used in a very liquid state, it has been necessary to introduce drying apparatus to dry the webs between printing on one side and the other, and also after printing on both sides before passing to the further operation of folding and delivering the printed product in sheets.

The use of rotogravure printing is spreading rapidly. An increasing number of newspapers and magazines are adopting this type of printing for feature sections in their Sunday issues or as inserts in their magazines. The fact is that the wealth of detail and the distinct reproduction of features, especially in group pictures, make the new process a wonderful agent for the reproduction of scenes and photographs of current events and advertising in any form or size.

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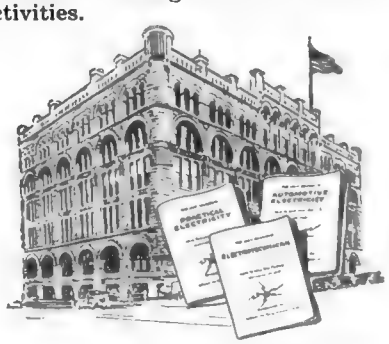

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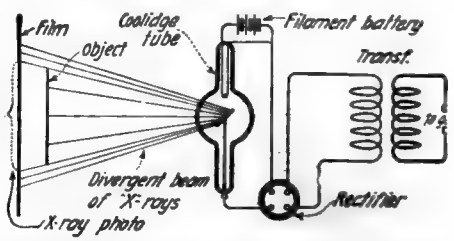
X-Ray Movies--Why Not?

By PROF. HAROLD F. RICHARDS, PH.D.

(*Continued from page* 1178)

angular skeletons make ardent love to each other. Dorothy and Percy are in the midst of their great moment. The scene is the porch of a country house in the summer time. It might as well be winter for all the X-ray will reveal of the setting. The two stars are seated in a hammock, which is invisible, so that apparently the skeletons are resting easily on air. Their jaw bones move grotesquely up and down as they exchange sweet nothings. The small-boned figure bears numeral "1" on its arm, produced by a piece of lead which has been fastened to the arm during the filming of the scene, but even without the number we have come to recognize the favorite star by the excessively slender ulna of her right arm and the peculiar three-pronged hairpins which stand out distinctly above her shapely skull. Percy wears the numeral "2," but his enlarged hip-joints, monogrammed belt buckle and



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heavily crowned wisdom tooth suffice to reveal his identity to the seasoned theatregoer. The jaw-wagging quickens—the situation is becoming more tense. Percy's right humerus and ulna creep stealthily around the twelfth rib of the slender-boned Dorothy. She struggles, and we see her ribs contract as the bony arm tightens its hold. Now she lays a submissive skull upon the clavicle of her lover. His ribs heave up and down as he realizes that the object of his adoration is his at last. The shadow in the left side of his chest fluctuates rapidly and we know at once that his pulse has quickened With gentle claws of bone Percy grasps Dorothy's delicate skull, deliberately raises it until her empty eye-sockets are on a level with his own, then suddenly draws it to his jaw. Teeth rest against teeth as the ardent kiss lingers its sweet length. A small skeleton on bicycle rides up, a monkey wrench and screwdriver bouncing merrily around in the tool bag. The loving couple spring guiltily to feet, the ball and socket joints at their hips moving smoothly. The rider dismounts, fingers with a bony hand at the left of his sternum, and extends something towards Percy. The latter accepts the offering and thrusts his fingers towards the front of his right hip. We see coins moving about as he feels for a dime. The messenger departs, while Dorothy and Percy appear to be reading. Apparently the news is good, for they dance a few joyous steps on the porch. We note with a pang of regret that Percy's tarsus has fallen so low that he has flat feet.

(*Continued on page* 1226)

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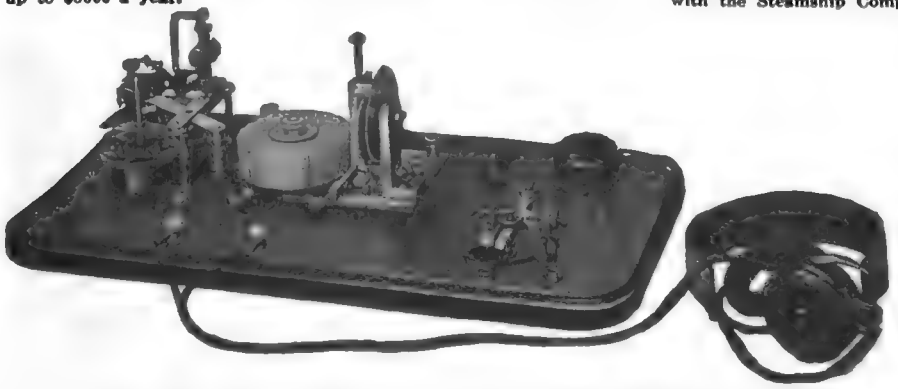

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X-Ray Movies--Why Not?

(*Continued from page* 1224)

The X-Ray "Villain" Approaches

Another skeleton advances stealthily from behind a tree. He is number "3," Hubert, the villain. His bony claws tighten about the vertebræ that connect Percy's head with his shoulders. Dorothy's tiny fingers clutch wildly at her skull while the two men clinch. We watch the conflict with breathless interest, for we see plainly the revolver inside Hubert's pocket. He draws the pistol and fires. Percy stretches his bones upon the earth. Hubert lifts Dorothy to the back of a huge, four-footed skeleton, which must be a horse, and they dash off. We look thru the gaps between their ribs and see trees flitting past!

How the Ordinary "Movie" Works

Before describing a possible mechanism for the production of X-ray movies I must direct attention for a moment to the requirements for ordinary movies obtained with the camera. As everyone now knows, the movement seen on the screen is simply an optical illusion produced by the rapid sequence of a number of still photos. Suppose that one second is required for the actor to draw a gun. The operator, in turning the crank of the camera, alternately closes and opens the diafram at such a rate that approximately sixteen exposures are made per second. In other words, sixteen instantaneous snapshots are made of the actor's arm while it is in the act of drawing the revolver. If these pictures are then flashed upon the screen at the same rate and in the same order as taken the effect upon the observer will be one of continuous motion, for the abrupt changes of position which would be observed if the snap-shots were thrown separately upon the screen at greater intervals of time are imperceptible when the succession takes place so rapidly. A similar phenomenon is obtained with sound. If successive sound impulses are sufficiently far apart in time the effect upon the observer will be that of a succession of noises, whereas if the impulses follow each other with sufficient rapidity the separate impulses will not be detected but the effect may be that of a musical tone. The rapid succession of "stills" is, then, the first requirement for motion picture photography.

The Elements of X-Ray Movies

Ordinary movies are produced by light which is *reflected from* the objects portrayed. An X-ray photograph, however, is due to the action of rays which have been *transmitted thru* the object depicted. When X-rays pass thru a material body they are absorbed by an amount dependent upon the density and thickness of the matter traversed, and the shadows upon the film simply reveal this absorption. Thus when X-rays penetrate the human body they are more nearly absorbed, *i. e.*, destroyed, by the dense bones than by the lighter flesh, so that the outlines of the bones are clearly shown upon the film. Obviously the requirement for X-ray movies is a means of focusing X-rays thru a wide aperture in sufficient strength to produce sixteen instantaneous snapshots per second.

We shall have two distinct classes of difficulties to overcome if X-ray movies are to be realized. These may be re-

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ferred to as difficulties of *focus* and difficulties of *energy*. With the aid of Figure 1 the meaning of these terms can be made clear. The diagram represents the usual Coolidge X-ray tube, which consists of a hot cathode and a tungsten target inside a highly evacuated glass tube. The high voltage drives the electrons from the heated filament to the target with such a velocity that they produce X-rays when they strike. The X-rays are electromagnetic waves in the ether of the same nature as visible light but of much shorter wave-length. These rays are given off from only a small spot in the ordinary tube, so that we may consider them as *diverging* from a point. It is apparent that so long as we have only divergent beams of X-rays there will be no hope of obtaining satisfactory movies, for the smallest photograph that can be made is at least as large as the object, and is even larger when the object is not placed next to the photographic plate. It is readily seen that the size of the image formed on the film will depend upon the distances of both the tube and the object from the film. It is impossible to regulate the size and definition of the images by use of a lens in focusing, for *no substance has ever been found to refract X-rays*. The ordinary type of X-ray tube would have to be placed very far from the actors in order to produce sharply defined and not greatly enlarged photographs of them. In this case the amount of energy sent thru the actors in the form of X-rays would be so small, due to the divergence of the beam, that exposures of long duration would be required for even a single photograph. The highest powered apparatus now available enables us to obtain an X-ray photo of a man's hip-bone with an exposure of three-quarters of a second when the hip rests on the plate and the tube is two feet distant. If the hip were farther away from the film, say six feet, it would be necessary to place the tube at a distance of thirty-six feet in order to produce an image of the same size as before (assuming the mean thickness of the hip to be eight inches). The distance of the tube has been increased eighteen times and the X-ray energy passing through the hip *decreased* by 324 times, since the energy falls off as the square of the distance. In this case a five-minute exposure would be necessary, and even then the picture would be very much blurred. Under such conditions there would be no hope of obtaining movies.

Apparatus for Making X-Ray Movie Dramas

Without going farther into the theory of the matter, I shall call attention at once to the large wash drawing where there is diagrammed a possible disposition of apparatus to obviate the difficulties of energy and focus described above. The small diagram represents a cross-section thru the whole set-up. The X-rays may be produced by a single tube—an enormous one, perhaps thirty feet in diameter. Special reinforcements would be necessary to prevent the collapse of the glass walls when the tube is evacuated. [A metal bulb might be used, fitted with a glass window. Ed.] The target consists of a segment of a huge paraboloid of tungsten or other metal capable of emitting rays of the necessary penetrating power. The hot filament to supply electrons consists of a great network of electrically heated wires placed before the target. X-rays will be given off in all directions and will *diverge* from the target. However, it would be more feasible, perhaps, to employ a "bank" of standard X-ray tubes as shown in the wash drawing reproduced herewith.

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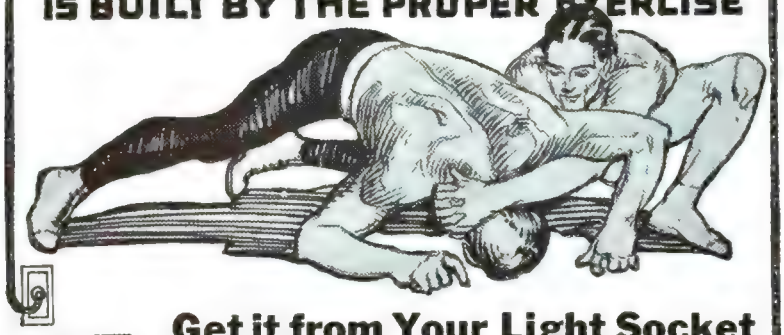

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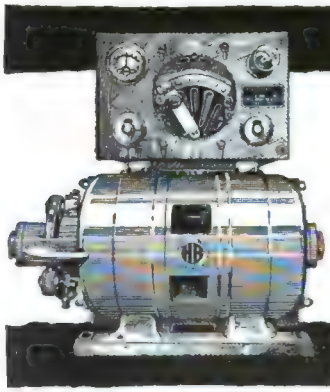

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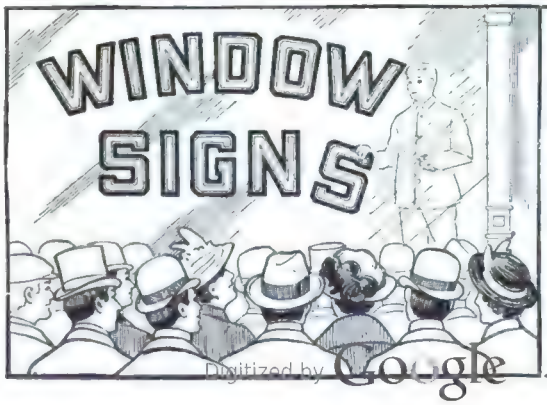

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We require, however, a *converging* beam focused on the opening of the X-ray camera. For this purpose I have devised what I venture to call an "X-ray lens," which consists of a thick shield of lead honeycombed with very narrow slits whose directions converge upon the opening of the camera. Any rays not traveling in the direction of the slits will be absorbed by the thick lead, and those rays that do emerge will be *focused* in a *converging* beam upon the diafram of the camera. The moving film travels automatically past the opening, which is alternately closed and opened by a diafram of lead so as to produce sixteen instantaneous exposures per second. The actors perform their parts in the space as diagrammed. A large transformer, or perhaps several transformers in parallel, will be necessary to supply the enormous amount of high-voltage electricity required to send the electronic current from the filament to the target and thus excite the X-rays. From the present knowledge of X-ray tubes it is impossible to state what power of current would be necessary to enable a tube of this design to emit the energy requisite to produce instantaneous photographs through the human body at such a distance. *The first development of X-ray movies will probably be accomplished by the use of large batteries of the X-ray tubes now made,* but there seems no doubt that higher powered tubes can be developed. X-ray photographs produced by the method outlined above could be developed, transferred to celluloid films and projected in the customary manner.

It is interesting to observe that the actors would be obliged to exercise care never to get behind one another, for in that case the skeletons of the two would be merged into one blurred image. The result would be analogous to that of a double exposure with the ordinary camera. Furthermore, it would be advisable for the actors to wear lead-glass goggles over their eyes and thin rubber shields about the pelvic regions, since these parts of the human body are most susceptible to the harmful effect of X-rays. In no case would the performers be able to act longer than a few minutes a day without harm to themselves, so that a considerable length of time would be required to produce a complete play.

In conclusion I must insist that my suggestion of this plan as a possible means of producing X-ray movies is only a tentative one at the present time. I feel, however, that there are no difficulties entailed which cannot be surmounted by research along the lines suggested, and I believe that moving picture companies might make the experiment with favorable outlook for profit. The possibilities for trick effects of a highly amusing nature seem unlimited, and weird results could be obtained by inserting a few feet of X-ray movies in the "legitimate" ones now made with light.

WOMAN FINDS NEW STAR

Another new star has been discovered at the Harvard Astronomical Observatory. The Nova is in the constellation Sagittarius, and was at its maximum brightness on Aug. 11 and 12, 1914, being then of the eighth magnitude, and since then has declined in brilliancy.

Miss Woods of the observatory staff detected the star, the position of which is given as right ascension 17 hours 59 minutes 44 seconds, declination minus 31 degrees 44.9 minutes (190). The discovery is the fortieth of its kind in the history of astronomy and the twenty-second in the records of the Harvard Observatory.

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The Devil's Understudy

By CHARLES S. WOLFE

(*Continued from page* 1188)

The telephone bell jingles just then, and the Chief leans his ear against the receiver and grunts. We hears someone yappin' on the other end of the line, and then the Old Man slams her back on the hook and glares at us. "Six more," he says, coldly, and poor Bill Lawrence groans.

I ventures to horn in. "Poisoned needle, maybe, eh?" I says, and the Chief looks thoughtful. "Maybe—yes," he says slowly, lighting a cigar. "Yeh, Marten, most likely you said it. That would leave only a small pin prick and wouldn't show up until the doctor gave the bodies a careful goin' over. Come on, you two, I want to look into this thing myself."

So the three of us whizzes down in the Old Man's Lizzie into the financial district where all this slaughter is goin' on.

Everything's on its neck when we gets down there. The people is standing around in mobs, everybody lookin' scared and ready to run. The boys on the corners is havin' the time of their young lives tryin' to keep cars from comin' together, as scared chauffeurs makes desperate attempts to get worse scared big guys away from there. Things looks just right for anything to happen.

The Chief runs the Lizzie into the curb alongside of the nearest hitching post. Habit he can't get out of since he sold his horse and buggy. We all jumps out, and just as we hits the sidewalk a portly old guy keels right over at our feet.

The Chief rips out an oath and blows his whistle as the crowd surges in. I pulls my gat and uses it as a club and Lawrence does likewise. Between us we keep the Old Man from being trampled to death until two harness bulls comes up and takes over. Then we kneels with the Chief and looks the unlucky old codger over.

All three of us has had considerable experience in these matters, and it only takes a minute for us to see that he's been gathered to his fathers, sure enough. But the funny part of it is, that we can't see no trace of what took him off. No bruises, wounds or anything. And you simply can't croak a guy without doing something to him.

A couple of more "flat-feet" is on hand by this time, and the Chief sends for the wagon. "Want the Doc to go over this stiff with a fine-tooth comb," he says to us briefly; all three of us keepin' right on lookin' for some clue as to how the deadly work is being got away with.

There's some commotion in the crowd, and I looks up to see a guy elbowing his way thru the mob as if he meant it. After a minute I make him. One of our gang, Frank Nelson. I nudges the Chief, and he beckons Nelson to join us. "Just the bird I want now," he says to me under his breath.

Nelson was the only "high-brow" in our outfit. College man, he was. One of them unlucky lads what's fitted for better things, but just can't seem to get their hooks on 'em. When Frank got out of college he made about a dozen starts and drew just that many blanks. Finally he's down to the point where he can take his choice between the "force" and "going to work." Some influential friend takes pity on him, pulls a few strings, and he lands in our midst—a full-fledged plain clothes man. Wasn't long before the Chief was right glad to have him hanging around. He wasn't nothing extra for

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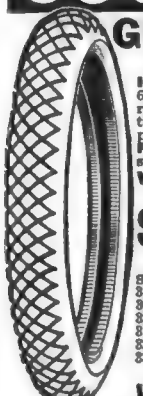

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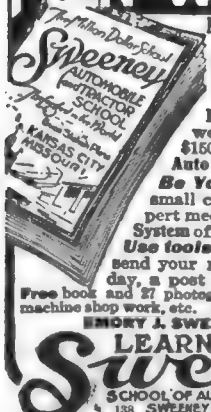

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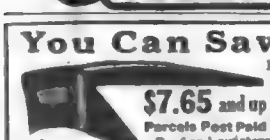

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going into a downtown saloon and picking out the particular dip he wanted, which is our everyday work, but whenever an odd case came up, he generally was there with both feet. He had a stock of odd and end knowledge that would take you off your feet, and the Old Man used him as a kind of a human cyclopedia.

Well, Nelson joins our family group and looks over the body. Finally he straightens up and gazes down on the corpse admiringly. "Excellent!" he beams at us. "I've seen so much killing of various sorts since I got into this business that I fancy myself as a conoosier. Now this is one splendid example of the art. Here we have a perfect specimen. The chap that did this certainly knows his business, and I can heartily recommend him to any one in need of such service as a thoro, all-around man."

The Chief frowns. "Can the small talk, Frank," he growls. "Got any idea how this fellow was bumped off?"

Nelson shook his head. "Not the slightest," he said, "except the conviction that some entirely unknown weapon is being used."

The Old Man jerked his thumb at me. "Marten has an idea it's a poison needle stunt."

"Marten's wrong," replied Nelson, decidedly. "I'm just from the morgue, where the department doctors are working on some of the others. There isn't a pin prick nor scratch on any of them. But it's murder, all right, for in the clothes of practically all of them we are finding notes warning them that they are marked for death, and counciling prayer and repentance. Some kind of a Red, judging from the tone of the notes."

"Well," the Old Man fairly bit out his words, "whatever he is, or whatever he's usin' don't make any difference in what we gotta do. We gotta get this gink, and we gotta get him quick. At his present rate he'll wipe out the town in a week. You don't know when he'll take it into his head to start on us, and if he does that you'll all wish you had used your brains a bit more. Scatter—dig into it! Here comes the wagon. Mix into this crowd and see what you can do."

Nelson grabbed me by the arm and drew me along with him. We got out of the jam, and Nelson pilots me into the back room of a nearby saloon. Over a couple of glasses of the nearest beer they had he opens up.

"Now then, Marten," he says, "I've been on the jump since the first guy got his, and I got a idea of how maybe this is bein' done. But I ain't got a ghost of an idea of who is doin' it. The only way that I can see we got a chance of finding that out is to lay a trap for the fiend. And traps are always baited. Now I know you got lots of nerve. Are you game to be the piece of cheese?"

"Tip me a little more," I says, cautiouslike. "The idea of bein' a target for whatever this guy's workin' ain't none too pleasant to contemplate. What's your idea?"

"Do you know Simonds, the big broker?"

I nodded.

"Well, he's on the list. Got a note, like the rest of 'em. I just left him before I joined you fellows. He's over in his office, scared to come out. Don't blame him much at that. You're about his build, and with a little alteration of your jib, some nice alfalfa like he wears, and so forth, I think we could ring you on this chap for the genuine article. We'll go over to his office, make you up; you come out on the street, me trailin' you, and see if I can get him."

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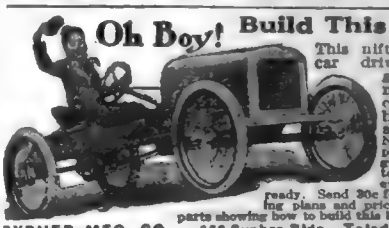

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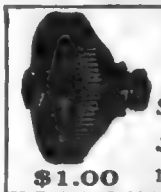

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"That'll be nice," I remarked. "And when the wagon's carted this bloomin' assassin away, you'll turn to the flat-feet and say: 'Now, boys, one of you shin around to Marten's widow and break it to her gently.'"

"Chances of that are about fifty-fifty," says Nelson promptly. "If my guess is right, you won't run much real risk. If I'm wrong, there'll be a strange copper in hell sudden. Are you on?"

Well, it's all in the day's work, you know. I shrugs my shoulders. "Lead on, Macbeth," I says, grimly. "I'll be the goat."

Nelson's already on his feet. "Outside," he orders. "Let's get going before you change your mind."

Well, we beats it around to headquarters and picks up a bit of make-up. While I'm gettin' my things together, Nelson blows out to do a little shopping and blows in again with a bundle. Off we go to Simonds' office.

We find Simonds in a funk. Scared stiff. We explain our idea, and he peels out of his duds. I study his phiz, and imitate it with Nelson's help. Finally Frank is satisfied.

"Now strip, son," is the next order, and I peels to the buff. Then Nelson unwraps his bundle and I see it's thin rubber sheeting. "Best I could do, old boy," says Nelson, as he wraps it around my carcass, fastening it as best he can. "No time to get you a suit of this stuff made."

"What's the idea?" I complains, for the stuff don't feel none too comfortable.

"It's your life preserver," says Frank, grimly. "Don't kick on it. It's the fifty chances that I said were with you."

Well, it's his party, so I dresses in Simonds' duds over my rubber wrappings, and out into the street I go to invite some boob to kill me. Out of the corner of my eyes I see Nelson loppin' along in the rear.

After a half hour of nothing happening, I kind of forgets the darned case. Got interested in readin' a big sign. And the first thing I know there's a commotion behind me.

I wheels, and there is Nelson wrestling a big old bird with bushy whiskers, who is hanging on for dear life to a black leather satchel. The crowd is already gatherin' in, so I double quicks into the melee. The next few minutes ain't quite so clear. That boy put up one terrific scrap, and we both had our hands full. I tried a couple of times to bore him, but I couldn't get a chance without shootin' right thru Nelson. But finally I gets the butt end of my gat against his dome and down he comes. Pantin', Frank slips on the wristlets, and up charges the harness bulls. "Wagon," orders Frank, and we keep a half hitch on the old boy till it gets there.

We drives around to the station, and the Old Man has a coniption fit when he sees what we got in the cart. The rest the world knows.

Our man turns out to be Professor Gleason, and the doctors find out he's warped from the Adam's apple up. And, brother, when we frisked that lad he had machinery strewed all over his clothes, including his satchel, which contained the "power plant."

He wouldn't give us a tip as to what it was all about, and somehow Nelson never could get the darned thing to work, altho he fust over it for months. I ain't sure, and neither is anybody else, just exactly how he done it. Nelson says he is sure, but I got my doubts.

Anyway, here's how Frank figures her. Maybe you know more about fancy "juice" work than I do. Most of it's over my head.

WHAT IS AN INTERNAL BATH?

By R. W. BEAL

MUCH has been said and volumes have been written describing at length the many kinds of baths civilized man has indulged in from time to time. Every possible resource of the human mind has been brought into play to fashion new methods of bathing, but, strange as it may seem, the most important as well as the most beneficial of all baths, the "Internal Bath," has been given little thought. The reason for this is probably due to the fact that few people seem to realize the tremendous part that internal bathing plays in the acquiring and maintaining of health.

If you were to ask a dozen people to define an internal bath you would have as many different definitions, and the probability is that not one of them would be correct. To avoid any misconception as to what constitutes an internal bath, let it be said that a hot water enema is no more an internal bath than a bill of fare is a dinner.

If it were possible and agreeable to take the great mass of thinking people to witness an average post-mortem the sights they would see and the things they would learn would prove of such lasting benefit and impress them so profoundly that further argument in favor of internal bathing would be unnecessary to convince them.

Few people realize what a very little thing is necessary sometimes to improve their physical condition. Also they have almost no conception of how a little carelessness, indifference or neglect can be the fundamental cause of the most virulent disease. For instance, that universal disorder from which almost all humanity is suffering, known as "constipation," "auto-intoxication," "auto-infection," and a multitude of other terms, is not only curable but preventable through the consistent practice of internal bathing.

How many people realize that normal functioning of the bowels and a clean intestinal tract make it impossible to become sick? "Man of today is only fifty per cent. efficient." Reduced to simple English this means that most men are trying to do a man's portion of work on half a man's power. This applies equally to women.

How many can you name, including yourself, who are physically vigorous, healthy and strong? The number is appallingly small.

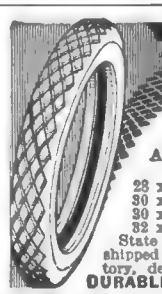
It is not a complex matter to keep in condition, but it takes a little time, and in these strenuous days people have time to do everything else necessary for the attainment of happiness, but the most essential thing of all, that of giving their bodies proper care.

Would you believe that five to ten minutes devoted to systematic internal bathing can make you healthy and maintain your physical efficiency indefinitely?

If you would keep your blood pure, your heart normal, your eyes clear, your complexion clean, your mind keen, your blood pressure normal, your nerves relaxed and be able to enjoy the vigor of youth in your declining years, practice internal bathing and begin today.

Now that your attention has been called to the importance of internal bathing, you will probably want to know WHAT an internal bath is, WHY people should take them, and the WAY to take them. These and countless other questions are all answered in a booklet entitled "THE WHAT, THE WHY and THE WAY OF INTERNAL BATHING," written by Dr. Chas. A. Tyrrell, the inventor of the "J. B. L. Cascade," whose lifelong study and research along this line have made him the preeminent authority on this subject Not only did internal bathing save and prolong Dr. Tyrrell's own life, but the lives of a multitude of hopeless individuals have been equally spared and prolonged. No book has ever been written containing such a vast amount of practical information to the business man, the worker, and the housewife; all that is necessary to secure this book is to write to Tyrrell's Hygienic Institute at No. 134 West Sixty-fifth Street, New York City, and mention having read this article in SCIENCE AND INVENTION and same will be immediately mailed to you free of all cost or obligation.

"Procrastination is the thief of time." A thief is one who steals something. Don't allow procrastination to cheat you out of your opportunity to get this valuable information, which is free for the asking. If you would be natural, be healthy. It is unnatural to be sick. Why be unnatural, when it is such a simple thing to be well? (*Advertisement.*)



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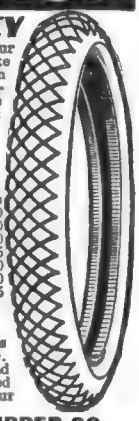

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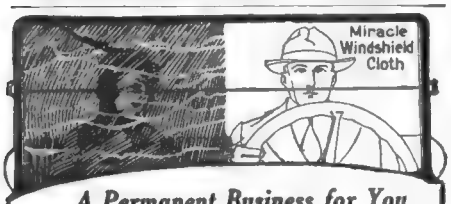

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Nelson says Gleason managed to electrocute his victims with juice from a few ordinary dry batteries. What? Yeh, I didn't think it could be done myself, but Nelson says it was a cinch.

There was two jiggers in the satchel that Nelson called the ray generators. They had lenses fitted on them. Frank says they brought the rays to a focus. Seems that there's some light that you can't see at all—ultra or infra something or other. Well, it is doped out that this old bird found one that would carry a current just as good as a chunk of copper wire does.

Nelson says he thinks the professor must have got a altogether new one, altho he says that there is at least one that's known to be a pretty good juice carrier.

Now the real big idea was this. These bloomin' rays of light penetrated like the X-rays do. Right under the hide they went. And along went the current, too.

Nelson says that once you get under the skin, which has great resistance, an awful weak current means a quick trip over the Big Divide. Forget now, but he did say. Let's see. Ain't sure, but it runs in my mind that it was seventy-five milli-amperes across the heart, or something like that. Don't know, but the doctors seemed to think that would do it.

All the old gink needed was a little outfit to make these rays and a few dry cells. He just bored you with two beams of them like any circuit, and turned on the juice.

Seems Nelson guest it was something like that and wound me up in rubber, hoping that that would be a insulator for the thing. *I know it was.*

And a little tip, brother. Gleason ain't the only bird that knows about light rays bein' conductors and all that. Get yourself some rubber underwear made. I got mine on right now.

Interesting Chemical Experiments

By O. IVAN LEE

(*Continued from page* 1206)

short a gas-pipe, or too little cooling water may cause the same result.

A more or less milky mixture of oil and water will drip from the end of the pipe, but in a short time you will see a clear pale yellow oil sink to the bottom in a layer underneath the water in the receiving vessel.

Continue the distillation as long as any oil drops seem to be coming over, changing the receiver, if necessary. Of course, there will be much more water than oil, but from three ounces of cloves almost half an ounce of oil should be obtained. With a little care, the water can be drawn off or decanted from the heavier oil. The oil of cloves remaining may then be freed of any water still mixed with it, by passing it thru a little cone of dry white absorbent paper into a small vial. To make this filtering cone, simply cut out a three-inch-wide circle of the paper, fold it across the middle and crease the semi-circle into quarters, opening one fold.

Naturally, the essential oil of cloves is about six times as strong as the clove itself, representing as it does, the very *essence* of the spice. Bearing this in mind, it may be used for the same purposes and, in fact, it is really much superior.

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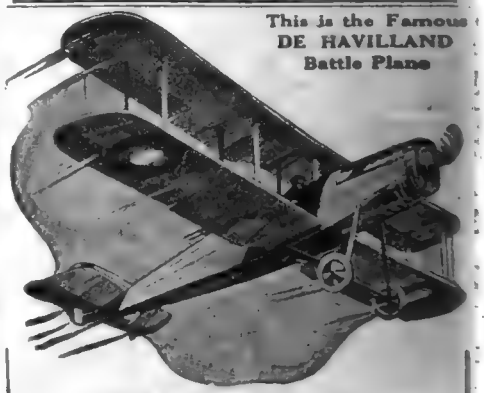

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Practical Chemical Experiments

By PROF. FLOYD L. DARROW

(*Continued from page* 1201)

solution any impurities that may be present tend to remain in the solvent. Because of this fact the purification of many substances becomes a comparatively simple matter. In the chemical industries, too, such processes are carried out on a very large scale. The Chili saltpeter beds, long the world's sole supply of nitrogen compounds for the manufacture of nitric acid, explosives and fertilizers, contain sodium nitrate mixed with rock and other foreign matter. To purify the salt, the ore is crushed, leached with water and then filter-pressed to remove the insoluble matter and obtain a clear solution. A considerable portion of the liquid solvent is evaporated and the remaining solution allowed to cool. This results in the separation of the saltpeter, i.e., sodium nitrate, in the form of crystals and leaves in the remaining liquid portion, called the "mother liquor," the impurities. One of these so-called impurities is a very valuable by-product, sodium iodate, from which is obtained a large part of the world's supply of iodine. The potash salts of Strassfurt, Germany, so valuable for fertilizers and chemical industries are

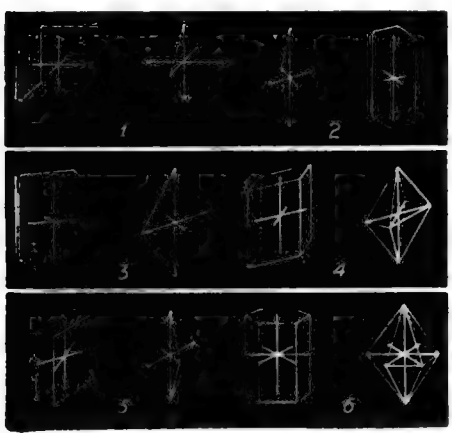

Fig. 1

The Six Systems of Crystals.

purified in a similar manner. And so, too, is the cream of tartar used in baking powders and obtained from the crude argol that crystallizes on the insides of wine casks.

In these processes of purification it is desirable to obtain as small crystals as possible and this condition is brought about by stirring the mixture thoroughly while the crystals are forming. If the crystals are large they will enclose small quantities of mother liquor. Where a very high-grade of purity is desired it is often necessary to recrystallize the product by dissolving in a small quantity of water, evaporating and cooling. After the crystals are formed they should be filtered from the mother liquor and washed with a small quantity of the pure solvent.

The purity of a crystal substance may often be tested by the determination of its melting point. Every crystal substance has a definite melting point, which is changed by the presence of any impurity. Therefore, to test the purity of a substance determine its melting point and compare it with the value obtained from a table of physical constants.

Preparation of Alum: In each of two beakers or other containers place 500 cc. of water. In one beaker dissolve 87 grams of potassium sulphate and in the other 171 grams of non-crystalline aluminum sulphate, using heat in each case if necessary.

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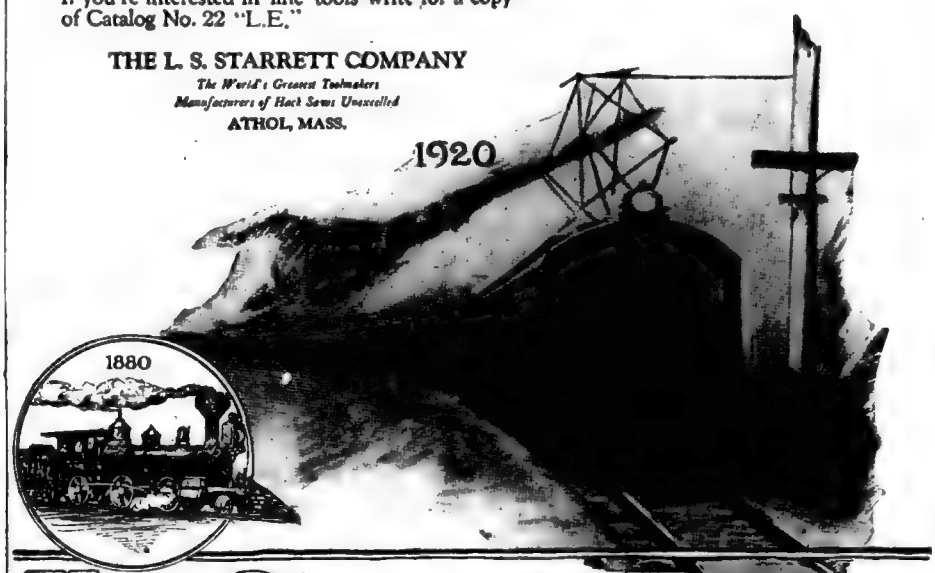

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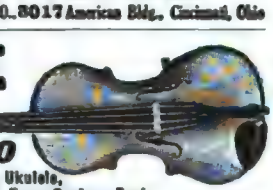

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sary. In a large evaporating dish mix the two solutions and placing the dish on a tripod over a Bunsen burner evaporate off from one half to two-thirds of the water. Upon allowing the contents of the evaporating dish to cool crystals of alum, which is a double compound of potassium and aluminum sulphate, will separate out. If small crystals are desired stir during the process of cooling. See Figure 2.

Growing an Alum Crystal: Make a saturated solution of alum by dissolving 100 grams of the salt in a liter of hot water and allowing the solution to cool. Then select a small crystal of alum and suspend it by a thread in the saturated solution that you have prepared. Allow this to stand undisturbed for a considerable period of time and slowly a very perfect crystal will grow. Figure 3.

Preparation of Glauber's Salt: This salt, chemically known as sodium sulphate, may be prepared in the same manner as alum. In 500 cc. of water dissolve 200 grams of the dry salt, using heat with constant stirring to bring it into solution. As before evaporate off about a third of the water and allow the mixture to cool. Clear, ice-like crystals will result. To preserve these crystals they must be kept in a glass container well stoppered so as to exclude the air.

Preparation of Chemically Pure Sodium Chloride: In a 500 cc. beaker place 150

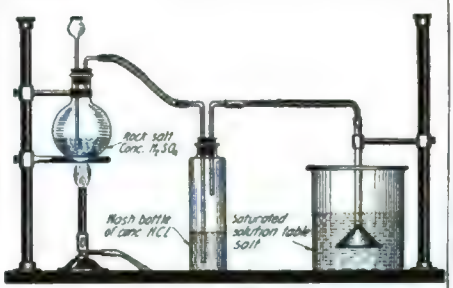

Fig. 4

Preparation of Chemically Pure Sodium Chloride.

grams of ordinary table salt. Add 360 cc. of distilled water and stir vigorously until no more will go into solution and the water is saturated. Then filter into a clean beaker and add concentrated hydrochloric acid until the salt just begins to separate from solution. Now set up a hydrochloric acid generator, as shown in Figure 4, connecting it with a wash bottle containing concentrated hydrochloric acid solution. With the wash bottle connect a delivery tube terminating in a 2-inch funnel and allow the latter to dip beneath the surface of the saturated salt solution.

Place in the generator a quantity of rock salt and cover it well with concentrated sulphuric acid and heat very gently. This generates hydrochloric acid gas which on passing into the salt solution drives chemically pure sodium chloride out of solution and precipitates it in crystal form. This results from the fact that sodium chloride is less soluble in hydrochloric acid than in water, and therefore the more chloride is thrown out of solution. Allow the salt to settle and pour off the clear liquid leaving the salt in the beaker. Cover it with pure dilute hydrochloric acid, agitate the contents of the beaker with a rotary motion, allow to settle and again pour off the clear liquid. Repeat this several times. Then filter through a filter paper and allow to dry. The product is chemically pure sodium chloride.

Preparation of Crystals of Iodine: Crystals are sometimes prepared without the aid of solution. Such is the case with iodine crystals.

Arrange apparatus as shown in Figure 5. In the test tube place a mixture consisting of 1 grain of potassium iodide and

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one-fourth its bulk of manganese dioxide. Upon this pour 2 cc. of concentrated sulphuric acid and warm the contents *very gently*. The beautiful violet vapor of iodine will at once appear and condensing upon the cold funnel will form a mass of jodine crystals. The crystals may be preserved in a well stoppered bottle.

This process, whereby a substance vaporizes and recrystallizes without first melting, is called *sublimation*. It is frequently employed to purify commercial samples of iodine. The apparatus for this purpose is illustrated in Figure 6.

Formation of Crystals by Supersaturation: A very interesting condition known as supersaturation is possible with certain salts. In a small beaker or Erlenmeyer flask place 50 grams of ordinary photographer's hyposulphite and cover with 10 cc. of water. Heat the mixture until it has dissolved and then allow it to cool without disturbance. When the solution has reached room-temperature drop into it a tiny crystal of the same substance and at the same time give the flask a quick shake. Immediately a mass of crystals will appear and the flask will become decidedly warm, illustrating the fact that a change of physical state is accompanied by an energy change.

Water of Crystallization: Many salts depend for their crystalline form upon water chemically combined with the salt. When this water is driven off the salts lose their crystalline form and crumble to an amorphous powder. Many of the rocks and mineral deposits of the earth contain water chemically combined. Thus the gypsum which covers the bottom of Great Salt Lake is crystallized calcium sulphate containing about 21% of chemically combined water. When we take this gypsum into our laboratories and drive off approximately half of this water we obtain a non-crystalline substance known as Plaster of Paris. When this Plaster of Paris is again mixed with water it chemically combines with it and sets into a hard substance. Hydraulic cement owes its marvelous property of indestructibility to its chemical union with water into a stony substance.

Water of Crystallization in Copper Sulphate: Into a dry test tube drop a crystal of copper sulphate, or blue vitriol. Heat the test tube and immediately water vapor will issue from it and condensing will cover the cold upper portions of the tube with water. At the same time the copper sulphate will lose its blue color and when cold you can readily crumble it to a non-crystalline powder between your fingers.

Now replace the powdered almost colorless salt in another test tube and cover it with a very little hot water. Heat the bottom of the tube gently in the Bunsen flame and when the sulphate has dissolved pour the solution into a watch glass. When the solution has cooled a deposit of blue crystals will appear on the watch glass, thus showing that the salt is able to take back its water of crystallization.

An Efflorescent Salt: Some salts containing water of crystallization will give it off simply on exposure to the air. Such salts are called efflorescent.

On one side of a horn pan balance place a watch glass containing a quantity of crystallized sodium sulphate, or Glauber's Salt. Counterpoise this with lead shot and allow the balance to stand for several hours. Soon you will notice that the bright crystals are losing their lustre and assuming a dull opaque appearance. At the same time the side of the balance containing the salt will grow lighter. These results are due to the fact that the salt is losing its water of crystallization.

Determination of Water of Crystallization: Simple quantitative work always appeals to the amateur chemist and the determination of the percentage of water

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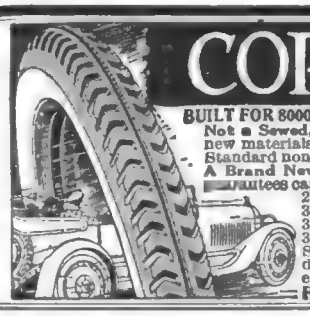

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of crystallization affords an excellent opportunity for such activity.

Exactly counterpoise a porcelain crucible on one side of a hornpan balance with lead shot. Then add to the lead shot a 2-gram weight and counterpoise it with crystallized barium chloride placed in the crucible.

Now place the crucible on a pipe-stem triangle over a Bunsen burner as shown in Figure 7. Using a small flame at first gradually increase the temperature and continue the heating for 20 minutes. When perfectly cold replace the crucible in the balance. Remove the 2-gram weight and again balance the crucible using a 1-gram weight and the small foil weights.

In order to be sure that all the water has been driven off heat the crucible again for 5 minutes, cool and weigh. If the weight is constant subtract this weight from the 2 grams of salt originally taken and divide this difference by 2. The result is the percentage of water of crystallization.

If you repeat the process a number of times the result should always be the same, for the water is chemically combined, and its percentage is invariable.

Crystals of Sulphur: Sulphur has the property of forming crystals of two distinct types—rhombic and monoclinic.

To form rhombic crystals dissolve a piece of roll sulphur about the size of a pea in a little carbon disulphide and allow the solution to evaporate on a watch glass. As it does so small diamond shaped crystals of the rhombic type separate out. Examine them with a small magnifying glass.

Monoclinic crystals are formed by just melting sulphur in a test tube and then pouring the liquid into a folded filter paper. Watch it closely and when the contents of the filter paper have just solidified over the surface open up the filter and pour out the still liquid center. A mass of needle-like, prismatic crystals will stand out from the paper. In a few days they will change into the rhombic form.

If instead of melting the sulphur it is heated until it boils and is then poured into cold water the sulphur assumes a non-crystalline plastic form.

Preparation of Potassium Nitrate: A very important application of crystallization together with differences in solubility due to changing temperature is to be found in the preparation of potassium nitrate. Hot saturated solutions of potassium chloride from one side of the Atlantic Ocean and Chili saltpeter from the Pacific Coast are mixed and allowed to cool. The result is potassium nitrate.

In 100 cc. of water dissolve 85 grams of sodium nitrate, using heat if necessary. In another beaker dissolve 75 grams of potassium chloride in 100 cc. of water. Heat the solutions to boiling, mix them and evaporate off part of the water. Then allow the mixture to cool and the potassium nitrate will separate out. Sodium chloride which forms at the same time remains in solution because it is nearly as soluble at low temperature as it is at higher temperature. A more complete separation may be effected by cooling the container with ice.

This article by no means exhausts the subject of crystallization, but it gives a start and will perhaps stimulate the reader to further investigation in this very interesting field.

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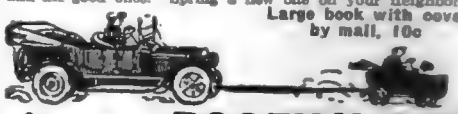

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This law is as old as the hills; used by the great and near great, the noble and the common and everyone who succeeds. It is a law requiring a substantial understanding of the proposition a person desires to promote for profit. It is a system, a combination of vision, knowledge and common sense applied to the business in question; a collection of data and facts of commercial requirements that surround any successful business. In a word the fundamental law of success is knowing the article or invention to be sold, the information necessary to manufacture or market it and the field of the possible demand it will have after it has been placed on the market.

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All these details should be taken into careful consideration in order to assure quantity production of the product. Only in quantity production can money be made. To obtain quantity production the article must be practical, simple and capable of being standardized. It must be extensively advertised to acquaint the prospective customer with its merit and usefulness.

Many a good invention has failed because so few people knew of it. When you have a useful improvement let the

*No queries are publisht this month owing to the article by Mr. Hobson.

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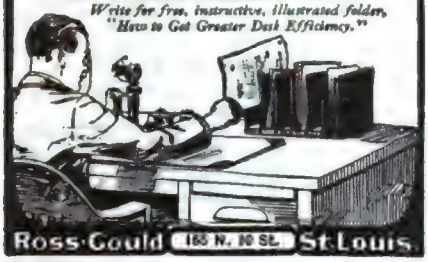

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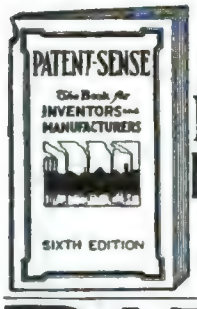

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world hear about it. Shout it from the house tops! Advertise in every conceivable manner. Spread the news before everyone, everywhere — and everyone everywhere will become your customers. After public patronage has been secured, render service, be square in all dealings and see that each customer is well pleased with the goods and they will reciprocate by sticking to you. The repeat business is where the largest profits are made.

I recall the experience of two clever young men who started a small business of their own with a good product, but limited capital, which is a handicap. Their product was a patented safety razor blade sharpener of considerable merit. They put it up in an attractive form and sold it through sideline salesmen calling on stores, premium stands, distributors and the like. They could not afford regular full-time salesmen on account of their limited finances; but their sideline salesmen were faithful and sold a sufficient quantity to keep their little factory on a fair paying basis, but nothing compared to the business and profits these two live members desired. They had visions of becoming the largest in their line.

Their ambition and willingness to pay the price of success was plainly evident, but they could not decide upon the best plan to accomplish the desired result. Careless experiments might prove disastrous. Their funds were limited and had to be carefully calculated in order to avoid any misstep that might lead to failure. For months they pondered over this subject.

One day they were eating lunch together in a popular café. Two other gentlemen occupied the seats on the other side of the table. These men were all smiles and deeply interested in their own conversation which concerned their respective businesses. The two young men opposite could not help hearing every word of what was said, which proved to be a revelation to them. One of the other men was explaining the details of how his company had grown from a little hole-in-the-wall to one of the largest of its kind in the field.

He outlined it step by step, carefully telling how it was done; that the secret of the entire progress was national advertising and quantity production, which made for a lower manufacturing cost by being able to distribute the lump cost over a greater quantity of their goods, thereby reducing the individual expense of each article and increasing their total net profits.

Through extensive advertising they were able to turn the capital invested several times yearly, making a smaller working capital possible. Then he further explained that dealers and jobbers preferred to handle a highly advertised article; and that their salesmen were able to interest new distributers who would not represent them before, because their goods were in small demand.

All this interesting conversation was eagerly devoured by the two young men who consumed more facts than food that day. However, it was just what they wanted; just the spark that would start their little idea toward the goal they had long dreamed of. Reaching their offices they delved into the firm's financial condition to see to what extent they too, could do national advertising and bring their factory to a quantity basis.

Many days were consumed going over details to ascertain their true position. Finally both agreed that it was possible. They consulted an advertising man and laid their plans before him for advice.

To be concluded in next issue.

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The Velocity of Light

By PROF. JAMES S. STEVENS

(*Continued from page* 1198)

experiment and afforded another illustration among the many of the mutual helpfulness of mathematics and physics.

Recently the value of the velocity of light has assumed especial importance in connection with the theory of relativity. It has been known for sometime that this constant represents the greatest value that a moving body can have. It has also been shown both from mathematical and experimental considerations that the mass of a body is closely dependent upon its velocity. *If it had no velocity it would have no mass; and if it moved with the velocity of light it would have an infinite mass.* Both of these conditions are, of course, impossible to realize. We should be careful to note that in the *theory of relativity* the velocity considered is the velocity with reference to the observer. If two particles were shot towards each other each with the velocity of light their relative velocities would obviously be twice the velocity of light; but the velocity of each particle with respect to an observer on the other particle would only be the velocity of light.

We may indulge in a few interesting speculations along this line with a distinct understanding that they will not be realized —at least in our generation. If a heavenly body was situated at a distance of a hundred light-years from the earth and on that body there was an astronomer with a telescope sufficiently powerful to permit him to see what was taking place on the earth, he would at present be observing events which took place in 1821. See Fig. 4. He would, for example, notice that a certain document was being signed by which the State of Maine was set off from the State of Massachusetts, and this would be his report to his fellow astronomers who might inquire what was going on in the planet Earth. If the distant heavenly body were moving toward the earth with the velocity of light the last one hundred years would be accomplished in just fifty years. At the end of fifty years the light and the moving body would meet and the astronomer who was observing would report facts happening in 1921. If the body were moving away from the earth with the velocity of light, the distant astronomer would be obliged to report that the earth was a very unprogressive planet. He might watch our operations for an indefinite period of time and he would find no change from the events which he first noted, namely, those events which were happening in 1821. If he moved with a velocity greater than that of light he would, of course, never see the surface of the earth.

This is a situation analogous to that presented by Jules Verne in his "Journey to the Moon." It will be recalled that the tremendous explosion which sent the projectile to the moon was never heard by the people who traveled with it. This was readily explained by remembering that the velocity of the projectile was considerably greater than the velocity of sound which was following along after it. A paper printed in the ELECTRICAL EXPERIMENTER a few months ago explained at considerable length a problem somewhat analogous to the one we have been discussing, namely, the relative motion of the earth and the ether. It is greatly to the credit of American science that in the absolute measurement of the velocity of light, the relative velocities of light in various media, and the question of relative motion of ether and matter American physicists stand out pre-eminent.

Be Physically Fit To Hold Your Job!

HUNDREDS of captains of industry and managers of big business state, in no uncertain terms, that they will not employ weak, impotent, physically unfit men and that those of their employees who do not measure up to their standards of physical and mental efficiency will soon be dropped from the pay-roll. *How about you?* Will you be discarded because of physical deficiencies—will you be hunting a new job one of these days and be unable to qualify physically for a new job? Don't wait until you are "fired"—THINK NOW before it is too late.

Have You Been Slipping and Backsliding?

Don't think for one moment that you and your work have not been watched. Being long established won't count when your employer realizes that you are not up to the mark. There is no sentiment in business. You may be well liked, but he can't afford to keep your name on the pay-roll if you don't get busy and produce real value for the money you get on pay day. Times have changed—men were scarce and jobs were plentiful—now men are plentiful and jobs are scarce. Business demands big, red-blooded, healthy men with big mental powers backed up by strong, vigorous bodies and an unlimited supply of endurance. That means that only the physically fit will be kept on the pay-roll. You must get strong and healthy or GET OUT! Where are you headed for? What will your future be? It's up to you NOW.

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Look the facts squarely in the face. If you were head of a big business, would you keep a weak, sickly, deficient man on your pay-roll? If you knew that an employee was a physical weakling, rotten with Constipation, Biliousness, wretched with Nervousness and Bad Habits, would you keep him on his job? If you knew that he came to work every morning with a dopy, woozy brain and the pep and ambition of a dead cat, would you continue to pay him good money for poor work? No, you would not. You would "fire" him. That's what your employer will do to you if you don't wake up and make yourself physically fit. You must build up your body and brain and stop falling down on your job. You can win with

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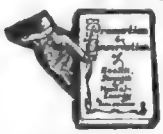

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The proof of this is shown by the fact that when organic iron is supplied to their blood, that all their multitude of symptoms often quickly disappear and the very men and women who were formerly so complaining now become strong, healthy and vigorous, with even dispositions and a sunny, cheerful nature. Nature put plenty of iron in the husks of grains and the skin and peels of vegetables and fruits to enrich your blood, but modern methods of cookery throw all these things away—hence the alarming increase, in recent years, in anæmia—iron starvation of the blood with all its attendant ills.

If you are not willing to go back to nature then you should eat more such iron-containing vegetables as spinach and carrots and reinforce them by taking a little organic iron from time to time. But be sure the iron you take is organic iron and not metallic iron which people usually take. Metallic iron is iron just as it comes from the action of strong acids on small pieces of iron and is therefore an entirely different thing from organic iron. Organic iron is like the iron in your blood and like the iron in spinach, lentils and apples. It may be had from your druggist under the name of Nuxated Iron. Nuxated Iron represents organic iron in such a highly condensed form that one dose of it is estimated to be approximately equivalent (in organic iron content) to eating one-half quart of spinach, one quart of green vegetables or half a dozen apples. It's like taking extract of beef instead of eating pounds of meat. Over 4,000,000 people annually are using Nuxated Iron. It will not injure the teeth nor disturb the stomach. A few doses will often commence to enrich your blood and revitalise your wornout, exhausted nerves. Your money will be refunded by the manufacturers if you do not obtain satisfactory results. Beware of substitutes. Always insist on having genuine organic iron—Nuxated Iron. Look for the letters N. I. on every tablet. At all druggists.

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Why We Grow Bald

By DAVID J. CALICCHIO, M. D.

(*Continued from page* 1180)

A few of the fine branches or capillaries of the left side unite or anastomose with the capillaries of the opposite side. Others do not unite and thus form terminal vessels.

These arteries fit in shallow depressions of the bones of the head. The vessels are not deep but very superficial. And since their bed is a solid, hard bone, one can easily understand, how the slightest compression, such as that produced by the wearing of hats, especially stiff hats, will stop the flow of blood, and deprive the roots of the hair of its blood supply or food.

The arteries are very elastic tubes. With each beat of the heart, enough blood is sent to the hair, in order that it may thrive and grow. But if there is an obstruction, either within or without an artery, or capillaries, the blood current stops and it ceases to flow, exactly as pressure on a gardener's hose, would prevent the outflow of water.

The brim of hats fit about one to three inches above the ears, and one cannot fail to notice, that the *hair always falls out from that point upward.* Below this line, that is, at the sides of the head (parietal regions) and back (occipital region) the hair grows very exuberantly. Accordingly there is no interference here with the circulation of the blood, since these parts of the head are always exposed and free from compression.

The forehead (frontal region) is relatively always free of hair, the reason being that no part of hair here is exposed, and no part free from compression.

Hence the three quarter ring of hair around the head with an interval at the frontal region, seen in bald people.

Women lose their hair less frequently than men. This is due to their ways of fixing their hats, which are held in position, not by tight fitting, as practiced by men, but by pinning the hat to the hair.

Of course, it is an established fact, that many diseases, and sometime fear, or worry, are responsible for the falling of hair or *alopecia.*

The daily wetting of hair and its improper drying, interfere with the flow of blood and growth of hair is damaged.

The falling of hair defies all our strenuous methods of making the hair grow, such as daily applications of hair tonics, singeing the hair, and the practice of massaging the scalp.

There is only one way to prevent the losing of hair, and that is, *the flow of blood which is the food of the hair must be kept free.*

Wear soft hats winter and summer. Keep the scalp free from all possible constrictions. Be bare-headed whenever possible. Stimulate and increase flow of blood to the roots of the hair by bending the head from left to right and *vice versa,* and forward and backward.

Five of these movements night and morning is enough at first. Increase the number of movements daily until you can repeat them twenty-five times, without becoming dizzy.

Remember that whenever the blood supply of any part is shut off, that part will die.

And it is only loss of time, money, and good faith to use expensive hair tonics, because they are useless, other than imparting a pleasant fragrance.

No doctor would be so unreasonable as to apply and employ liniments, ointments; massage and friction to a limb, whose blood vessels are severed, in the hope of restoring it to normal state. What he would do

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is to provide the limb with blood vessels, so that blood could be brought to it.

The hats of conductors and motormen, are well provided with openings, to insure good ventilation. This is done with a view of preventing the hair from falling. And yet almost every other conductor and motorman is bald.

You know what happens to flowers, trees, and vegetables when irrigation is wanted. They die. The same happens to the hair.

The cause of gangrene is the sudden or gradual deprivation of blood for the affected part. And the only cure for gangrene is amputation of the gangrenous part. No treatment can save it.

No treatment can save your hair, but an abundance of blood supply to the roots of the hair.

If your head is not entirely bald, even if very fine hairs or *lanugo* are still to be seen or left, then by increasing the flow of blood to their roots, you will not only prevent and stop their falling, but actually increase their growth, both in number and thickness.

General hygienic attention is also of value and important as an adjunct to what has been already suggested.

Drink plenty of water, seven to twelve glasses a day. Bathe your body frequently. Walk in the sun a few hours daily. Sleep with the windows open winter and summer. Outside air is always purer and better than inside air. Outside air contains more oxygen which is prepared by the vegetable kingdom and is the supporting element of life; and less carbon dioxide which is prepared by the animal kingdom, and is destructive to the body.

Building a 150 to 20,000 Meter Radio Receiver

By BERTRAM C. ROGERS

(*Continued from page* 1209)

insulating tubing or sleeving. It is a good time to state here that the successful operation and high efficiency of this outfit depend on careful workmanship. This holds true of any radio equipment, but any amateur who has progrest thru the more elementary stages should have no difficulty if ordinary care and some good judgment are used. The relative arrangements of coils and switches does not matter except that taps to switch points should be made as short as possible. The writer found it convenient to arrange taps as per diagram, the switches rotating outward from the center for an increase of inductance, thus eliminating mistakes when wiring. The large coils connect to the left-hand set of switches, the smaller being controlled by those on the right.

It will be noticed in the internal view that springs wound from steel piano wire (non-magnetic phosphor bronze wire is best) are used to counterbalance the weight of coils. As successful tuning depends on delicate adjustment of coupling, it will be necessary to detail the method of counterbalancing.

Referring to our trigonometry: If the length of spring is made approximately equal to the radius of swing of coil, force in downward direction at any position tending to rotate the coil is proportional to weight of coil times the sine of the angle at that point. $F = W \sin \Theta$. Now the pull of the spring varies directly in proportion to its length, provided double its normal length is not exceeded. Therefore as the length of the spring must also vary with the sine of the angle Θ the pull of the spring will be equal to and opposite

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Type 166-12 ampere for 6 volt battery...$32 Type 1612-7 ampere for 12 volt battery.$32
Type 1626-12 amperes or 7 amperes in combination for both 6 volt and 12 volt batteries.$46

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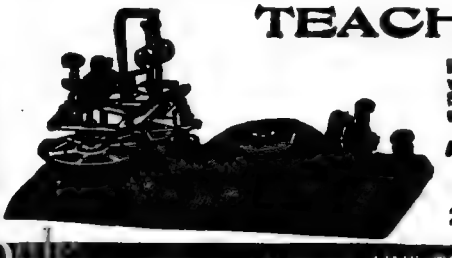

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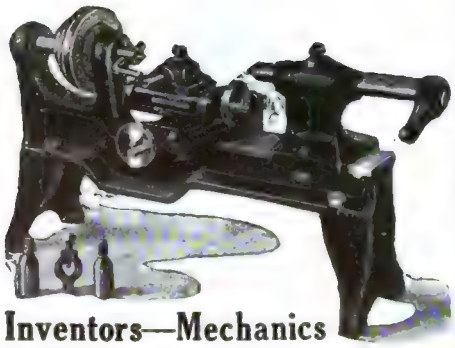

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to the pull of gravity on the coil. With a little experimenting with springs of various tensions, coupling control may be made very sensitive and the coils will "stay put" in any position.

In general loose tickler, tight coupling and shunt primary condenser is the order for long waves. Variable tickler, fairly close coupling and series primary condenser will control the shorter waves. Positions vary with characteristics and constants of tubes and antenna systems and are determined only by trial.

The bulb unit is conventional, a key or anti-capacity switch making a complete change-over from one-stage amplification to the second stage, 0–1 ammeter for detector filament, 0–2 ammeter for amplifier filaments and 0–10 voltmeter for testing "A" battery and switch and external resistance having a multiplying factor of ten with a three-point switch (middle point dead) for control to read "A" or "B" battery voltage at will. The top binding post to the right is for positive amplifier plate voltage, next is the detector plate, then comes the common negative and the lower six volts positive. Clamps and leads are being added so as to allow placing of block "B" batteries inside of cabinet. The cabinets were made from one-half inch birdseye maple.

Double phone clips and a filament current interrupting plug are on the bottom of the panel. The three-point switch to the left will cover two points at once and with studs connected respectively to 1, 3 and 2 plates of fixt bridging condenser it is possible to obtain values equivalent to 1, 4, 3, 5 and 2 plates. Plates are 2x2 sheet copper, tinned, thirteen plates total, separated by 2 mil mica. This gives sufficient capacity and regulation for the entire range of wave lengths. Transformers are of the Navy type 1:3 ratio and are mounted on a sub-panel below bulbs.

The amplifying unit is due for rewiring—as a great many changes were made on both sets trying out different hook-ups. The key switch on the left of the receiving cabinet was used to series both sets of coils, then to throw primaries, secondaries in parallel, etc., as well as for other experiments, but none of them were found worth while, the best results being obtained with the conventional three circuit hook-up as shown.

It will be found advisable to use a double cotton or silk covered stranded copper conductor for wiring the receiving cabinet. The bulb cabinet should be wired with No. 12 soft drawn bare copper wires, separating these wires at least one inch where it becomes necessary to run them in parallel; all crosses to be at right angles and in short, spacing tubes, transformers and wiring as far apart as possible, keeping all runs short. Bridging condenser leads must be short to prevent howling when receiving long waves. For practical purposes the one stage only is used for all work, especially the longer waves. When listening to music, time signals, etc., it is often convenient to place phones on table and throw over to the second stage. Western Electric P-11 phones are used. Marconi bulbs are shown, but an Audiotron for detector and Western Electric's bulbs for amplifiers produce the best results. Disregarding "A" battery and rectifier, the complete parts for the set may be bought in the market for about one hundred dollars ($100.00) and will take a week or two to assemble, depending on the builder's skill and old apparatus he may have on hand. The writer studied a great many sets to determine which would be satisfactory, but they all had some drawback, which was the reason for the design of the receptor. Six months' continuous use has proven its worth and permanency.

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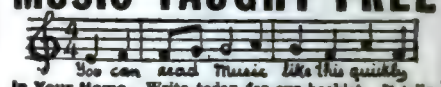

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The Edison Effect and the Audion

By DONALD C. McNICOL

(*Continued from page 1208*)

application filed February 2, 1905, claims substantially as follows: "This device is intended to take the place of the coherer in wireless telegraphy. It consists of a receptacle with electrodes containing a gas. This is rendered partly conductive by electric heating, which brings the gas into ionic activity and makes its conductivity sensitive to electrical oscillations."

The Work of Buff

The *National Telegraph Review*, New York, of July, 1853, contains the following significant report:

"Professor Buff, of the University of Giessen, has recently published an interesting paper on the electrical properties of flame. He has come to the conclusion that gaseous bodies, which have been rendered conductive by strong heating, are capable of exciting other conductors, solid as well as gaseous, electrically.

"Two small strips of platinum were introduced into a glass tube closed at one end; they were separated by an interval of a thin line of air. The air within the tube could not be heated to a degree sufficient to permit the electricity from two Daniell's cells to pass thru it. When the glass became soft by heating, and both pieces of platinum were permitted to touch it, a strong deflection of the needle of a galvanometer was the consequence.

"When the strips of platinum were exposed to the direct action of the flame of a spirit-lamp, the first notice of the passage of electricity was obtained when they were placed at about three inches above its extreme point, and began to show signs of redness. The deflection increased as the strips were lowered in the flame. When the flame was strongest there was a permanent deflection of 70 degrees. The flame current past always from the hottest platinum strip, thru the separating interval of gas to the other strip. When the metallic wires or other conductors connected at one end were brought into contact with highly heated gas, it formed an electric circuit. One platinum wire was introduced into the obscure center of the flame of a lamp, and the other wire was brought near the outer surface of the flame; a current of electricity immediately exhibited itself, which past thru the flame from the inner to the exterior wire. By properly connecting a platinum wire, which was dipt into the center of the flame, with a condensing plate, the latter became charged with negative electricity, and hence Prof. Buff concluded that positive electricity is given off by the outer surface of the flame."

Had Buff been able to heat the interior of his glass tube by means of an incandescent filament he would have made the same demonstration Edison made, but it was not until nearly thirty years after Buff made his experiment that the incandescent lamp was perfected by Edison.

INSTITUTE OF RADIO ENGINEERS ELECTS OFFICERS

The annual election of officers recently held by the Institute of Radio Engineers resulted in the election of E. F. W. Alexanderson, president; Fulton Cutting, vice-president; A. N. Goldsmith, secretary, and W. F. Hubley, treasurer. The Board of Direction of the Institute is made up of the officers and the following managers: E. H. Armstrong, W. H. G. Bullard, E. H. Colpitts, L. Espenschied, J. V. L. Hogan, L. R. Krumm, R. H. Marriott, Donald McNicol, and George O. Squier.

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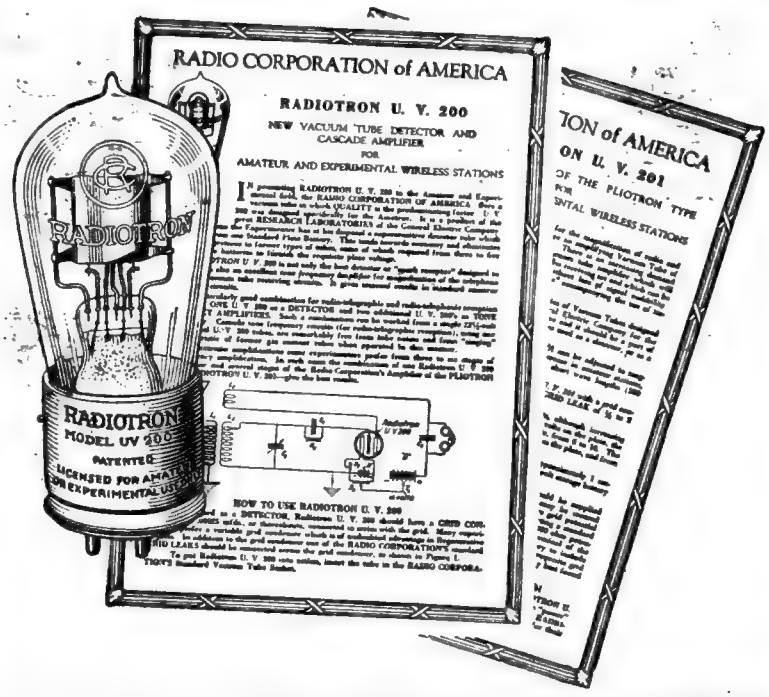

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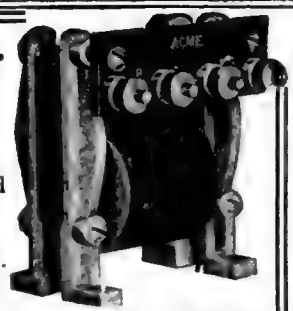

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How We Feel

By JOSEPH H. KRAUS

(*Continued from page* 1179)

particular, on the side opposite to the direction toward which the hair slants. When a repeated rhythm is applied to the skin, such as for instance a hair fastened on to a tuning fork, we are able to perceive a continuous sound from the fork, yet we can feel that this hair when touching the skin gives us a distinct series of discontinuous taps. When faradic currents are applied to the skin, they can be recognized as distinct separate sensations, even when repeated at the rate of 130 per second.

Fatigue of Touch Sensation

If a finger is placed on a small cog wheel from a clock, a continuous sensation is not felt until the cog wheel revolves at such a rate that there are more than 600 serrations making contact with the skin every second. Like nearly all sensations, the sensation of touch finally becomes more and more ineffective yielding to fatigue but not very rapidly. A cavity in a tooth or a gumboil at first is very annoying, but after a while we may not notice it at all.

It is a strange but positive fact that the sense of skin touch is much greater than that in the nerve trunks themselves. Thus, for a nerve trunk it has been found that a stimulus of .2 gram moving at a rate of 140 millimeters per second is necessary to evoke any sensation from exposed nerve areas but for the touch spots in the skin, a stimulus of .2 gram moving at only 17 millimeters per second is adequately sufficient.

Another surprising fact is that the sense of touch is greatly augmented by a profusion of hair on the skin. When a slight touch is applied to the hair proper, it acts on the long lever arm of the hair and multiplies the force of pressure so applied five or more times, because the hair is pivoted at the surface of the skin and the small arm of the lever projects thru the skin, into a hair follicle profusely surrounded by nerve endings.

It has been found that before the skin was shaved, .2 milligram pressure was effective, whereas after being shaved *it required a 36 milligram pressure* to produce the same feeling of touch.

Quality of Discrimination

Let us now consider a different sense, viz., that of discrimination or what is otherwise known as the *spatial quality* of touch. If any part of the skin of the body is stimulated by applying a cork point to the skin, we can instantly tell the exact location of the excited spot. If now, instead of one point, two cork points are substituted in a pair of dividers, there must be a certain spatial distance between these points, varying in different parts of the body, before we are able to definitely determine whether or not there are two points or only one point in contact with the skin.

In calculating this it has been found that at the tip of the finger a distance of 1.1 millimeter is required; any smaller distance will not evoke two distinct sensations. On the palm of the hand, a distance of 6.8 millimeters is necessary, whereas in the middle of the back, 67 millimeters, more than ¼ of an inch separation is necessary.

(*Continued on page* 1250)

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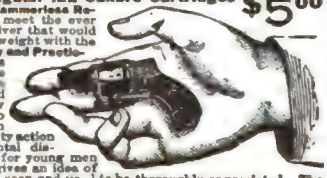

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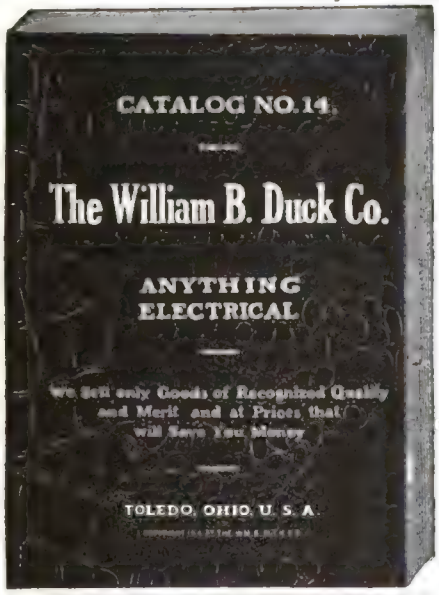
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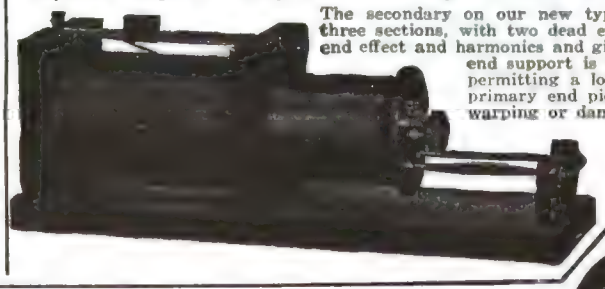

The secondary on our new type Arlington is divided into three sections, with two dead end switches, eliminating dead end effect and harmonics and giving greater selectivity. The end support is similar to that on our Navy, permitting a looser coupling. The base and primary end pieces have a spline to prevent warping or damage in transit. This feature is also on our Navy. It is a beautifully finished instrument.

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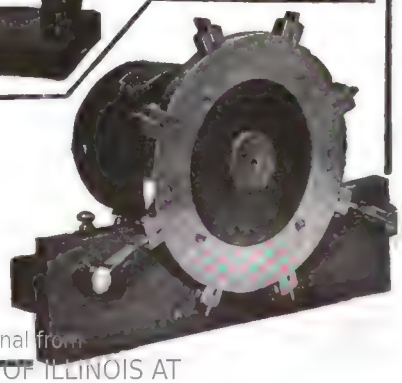

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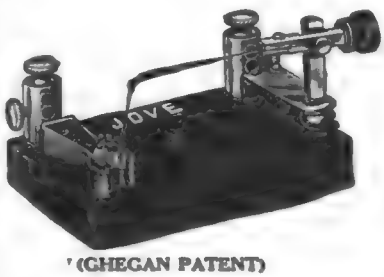

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How We Feel

(*Continued from page* 1248)

Try placing two contact points about ¼ inch apart on your upper arm, and see if you can tell whether there is only one point touching the skin or two. There is a continuous decrease of the distances of discrimination as we pass from non-mobile parts to mobile parts (from the upper arm to the fingers and from the cheeks to the lips), yet any factor which will diminish the sense of touch also diminishes the sense of discrimination such as cold.

How We Tell "Hot" and "Cold"

Let us now consider the *temperature senses* by means of which the skin can appreciate that a body coming in contact with it is either cold or warm. If the body is of the same temperature as the skin, no sensation is generally excited. Neither are the senses of warmth and cold produced by one and the same end organ.

The experimenter can readily determine this for himself by warming a small pointed glass rod and passing it over the palm of the hand. Certain regions in the hand will then give us a sense of warmth. Others give us a medium sense, while in still other spots no sensation will be evoked by touching the skin with the glass rod. If a rod is, on the other hand, cooled to a few degrees below body heat and moved over the same regions, cold spots can be definitely outlined. Note figures 1 and 2.

An investigation of these warm and cold spots shows that the apparatus for the appreciation of cold is much more distributed over the body than that of warmth, as is evidenced by our diagrams. The cold areas are best marked on the chest, the nose, the abdomen, etc., and both cold and heat are less sensitive on the face, hands and mucuous membranes. We can, therefore drink hot drinks, which, if applied to the hand and other more sensitive parts of the body, would prove very painful.

When the skin is very cold or very hot, it is much more difficult to recognize a change of temperature, but even a change of 1/5 degree, between 27 degrees and 32 degrees Centigrade, is recognized. If a cold pencil should be past over heated spots, no sensation whatsoever is registered in our brain.

When pressure is applied beyond a point necessary to evoke a tactile sensation the pressure becomes painful, and this is generally a point just before a sharp instrument will cause penetration of the skin. It is really remarkable that pain may result from the internal organs of a person, which organs are generally devoid of such sensations, as for example: the intestines may be cut, sewn, and otherwise manipulated without causing any sensation. If a strong contraction of the muscular walls of these intestines cause pressure from the catgut, a griping pain will result. A burning sensation is the result of a stimulation of the nerve endings of warm spots as well as pain spots.

In addition to the areas already charted out, we have certain areas of the skin from which only painful sensations are aroused. If the skin is then anesthetized, the patient will know (if pricked with a needle) that he is being pricked, but has no objection to any amount of repetition since the sensation is devoid of all pain.

All these sensations taken collectively give man the extraordinary power of knowing what is going on about him and protecting himself from dangers which may occur.

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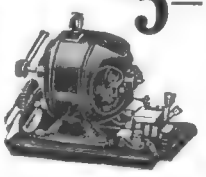

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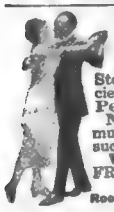

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Dr. Pringle Discusses Mind

By JOHN H. DEQUER

(*Continued from page* 1190)

sea, causing the fresh rain water to flow from the land gradually forming creeks and rivers which took up some of the life from the sea. And as the continents became more vast, the lakes and rivers dried up, the fish were left to adapt themselves to the land conditions. This is still going on in some of the drying rivers of Australia. Thus as the continents raised, the land animals evolved. These animals could not survive unless they moved toward food and moisture. From this necessity evolved the greater complexity of brain cells which orientates and reacts to the substances and conditions necessary to organic survival, and this system of orientations and reactions manifested thru brain tissues and expressed thru physical organism, we call intelligence; and the force or forces causing these reactions we call mind. Mind is the cause of intelligence; intelligence is the reaction of brain cells to mind forces. What constitutes the mind force, and how it is related to other subatomic forces, is what I am trying to find out."

"You are trying to verify the theory of evolution," I interjected.

"No," he replied, "I am not trying to verify or disprove any theory. I am interested only in truth." And then returning to his original subject, he went on, "I have fixt it so that the salt water flowing out of this pool runs into another where the fresh water from the creek flows into it. A little further down is another pool where the sea water is still more diluted. This gives me an opportunity to study the same life under various dilutions, pressures, and light effects. It shows me the effect of changing environment on the structure and functions of the various organisms under my observation."

"You are trying to duplicate on a larger scale the experiments of Loeb on sea urchins and other creatures," I suggested.

"Yes, you may put it that way," he assented, and then pursuing the original thought, he said, "Ultimately we may discover that life and mind are but the positive and negative poles of the same force, or combination of forces. I was just now thinking of the researches of Bose; doubtlessly you have heard of him. He is the great Hindoo who has forsaken his temple for the laboratory, and who in the laboratory is approaching closer to the causative power of the universe than ever did his dreaming ancestors. He tells us that in some mysterious way all matter is alive. That a bar of iron is as irritable as your mother-in-law, as can be shown by the galvanometer; and that it has its periods of activity and rest, as well as other characteristically vital phenomena. It is not improbable that life is the electron-combining force, and that in this sense the entire universe is alive. It may be that the different atoms are combined by vital activity under the influence of catalysing food products, and that mind is primarily a highly complex expression of that force operative in and thru protoplasm. Life may be the power, and living things some of the tools nature uses in her architectural work."

The sun shone warmly thru the window in the south side of the laboratory, and Doctor Pringle arose from his bench and adjusted a convex mirror so that it threw a concentrated beam of sunlight on the glass near the bottom of the

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and tried to ride a bike for the very first time? You thought that you would never learn and then—all of a sudden you knew how, and said in surprise: "Why it's a cinch if you know how." It's that way with most things, and getting a job with big money is no exception to the rule, if you know how.

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aquarium. In a few minutes the glass where the light entered was covered with small living things which he called, "Spirographis." As I watched these curious little creatures, he called my attention to some hydroid growth in the bottom of the pool. This too was turning its heads toward the light.

"That is heliotropism," he explained. "Solar energy is entering the structures of these creatures causing an effect not unlike that which iron experiences when brought under the influence of magnetism. It activates their photo-sensitive substances according to the Bunsen-Roscoe law."

"But why not grant that these creatures are controlled in their actions by instinct implanted in their nature by an all-wise Providence," I suggested, knowing full well that such a remark would draw his fire.

"That all sounds very well, but as usual in all mere speculative reasoning it removes instead of solves the problem, for I might ask you, what is instinct? How does it arise, and how are you going to reconcile the fact that 'all nature is red in claw and fang' with the conception of an all-wise, and hence necessarily benevolent Providence? No, no my friend. The Providence you dream about may or may not be a reality. I am not searching for it. I search for the secret of life and mind, feeling sure that these things may be explained by the observable and verifiable mechanics of ether.

"Young John Hays Hammond constructed a machine, electrically operated, the circuits of which were attached to selenium cells placed in the focus of two lenses, separated by a wooden board that does duty for a nose. The selenium as you know, becomes an electric conductor under the influence of light, and so John's mechanical device followed a lantern as if it were afraid of the dark. A savage would have called this machine intelligent, believing that it chose to follow the light, while we know that it could not help itself, realizing that light makes selenium a conductor of electricity. But like the average man we say that an animal chooses to follow the light not knowing the effect light energy has upon the protoplasmic granules of its cells. If we knew just what these forces wrought, we would realize that our actions are just as much compelled as those of Hammond's machine."

"You consider the conduct of living things as not due to mind, but rather to forces producing chemical change in the nerve tissues?" I ventured.

"All phenomena, whether physical or mental are due to forces producing electrical, and therefore chemical changes in the substances involved. We know of no mind phenomena that are unaccompanied by physiologic effects, and there are no physiologic effects without molecular change. When you trace it right down you will find that all mental and physical states are due to changes in the tension, stress or strain of the cosmic ether. The fact that we do not see, or consciously experience etheric change is because the atoms of our bodies are but slightly resistant to its movement. This has led men to postulate a universal something capable of brain reactions similar to his own. Superstitions are born of Ignorance and Credulity; these ought to have no place in the Temple of Science.

"Science is slowly but steadily climbing the great mountain of truth. It is learning that this universe is not the result of brain reactions, but of energy operating according to its inherent laws. *Brain is not the cause but the result of energy;* it grew up in beast and man in response to necessity of multiplying numbers and changing environments. These factors caused the life forces to express

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themselves in ever greater complexity thru brain tissue and in whatever direction they flowed the brain cells increased. Thus brain is a creature of this complexity of forces, and not as some suppose their creator. Intelligence is but the result of a greater or less complexity of brain structure thru which the action-determining forces flow."

From an ice box my friend took a piece of fibrous looking substance and suspended it by means of a silk thread to the cross arm on a metal standard. "This is nerve tissue," said he. Then by means of a lever he brought a large iron-cored electro-magnet having a lifting power of four hundred pounds to each pole, into close proximity to one end of the slightly desiccated tissue. To my surprise I saw it leap toward the magnet as if it had been iron.

"That is due to the iron content in the nerve," I suggested.

"Hardly," answered the Doctor. "Iron in combination with other elements is not necessarily magnetic. Take the blood as an example. It is much richer in iron than are the nerves, and yet it is distinctly diamagnetic, almost as much so as is copper.

"One of my reasons for maintaining that the dynamic power exhibited by animals having an active circulatory system is due to a form of electric power evolved in the body, is based upon the fact that the blood being diamagnetic, circulates in the magnetic field of the earth, thereby transforming the potential energy of nature into the kinetic energy of life. But what I want to show you is that not only is nerve tissue affected by magnetic force, but that all other body tissues are influenced as well. All cells are basically the same. They differ only according to the fluid in which they develop."

For the next twenty minutes Doctor Pringle performed a series of experiments with a great variety of tissues, proving that most of them under certain conditions were responsive to, or repelled by magnetic flux.

While performing these experiments he kept up a running fire of conversation. He discussed all the familiar laws of electricity and magnetism, as well as of radioactivity, and other recent discoveries in the domain of chemistry and physics. He talked with ease and familiarity about the great men in these fields of human endeavor as if they were his constant companions. And no wonder, for aside from his continual experimentations Doctor Pringle is an omnivorous reader of scientific literature. I remember only the "high lights" of what he said, my attention being specially drawn to his work. He was placing living animals in an intensified magnetic field and by means of an Einthoven string galvanometer proving how the electric potential of their bodies was increased by the concentration of the magnetic force about their organism.

"Magnetism cut by a diamagnetic substance evolves electricity," he said. "Electricity in motion sets up a magnetic field at right angles to the direction of its flow. At least that is what old man Oersted told us about a hundred years ago. He was not exactly correct in his statement. An electric charge repels the ether in its vicinity causing it to spin about the moving electrons. Thus we have the blood cutting the magnetic lines of the earth causing currents of electricity in the body which concentrates the magnetic field in their vicinity making the body a highly complex mechanism productive of electric, magnetic and radio-active forces. Both mental and physical power I conceive as the result of this interplay of different forms of primal energy."

While he talked he exhausted a bell jar by means of a mercury pump. This done he turned a switch causing a stream

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of cathode rays to play in the highly rarefied air. "That is a stream of electrons," he said. "Now I will show you that some of these cathode rays can be bent by a magnet in the same way that it would bend fine wire. Others of these rays will be unaffected, and still others will be bent in the opposite direction. These three rays are called Alpha, Beta and Gamma after the first three letters of the Greek alphabet. They are penetrating rays and doubtlessly have a far-reaching effect upon the life processes."

From a drawer in the table he took a series of negatives showing how he had actually bent light rays from their course by the action of his powerful electro-magnetic coil. Next he took a large photographic plate wrapped in red paper and laid it on a metal table. He covered it with a piece of wooden board more than two inches thick and adjusted his powerful X-ray tube over it in such a way that the rays would pass thru the intense magnetic field of the coil. After letting the rays play on the board for a few moments he took up the plate and handed it to his assistant for development. He then once more turned his attention to the nerve fiber, and showed how it, like all other magnetic substances, possessed distinct polarity, one end being apparently attracted and the other repelled by the magnet. "All human tissue, whether in health or disease manifests this power," he averred. "Health has been called the electro-positive condition of the cell, and disease its opposite. The electric and magnetic polarity of an organ is now being utilized by some of the world's foremost diagnosticians in their efforts to determine the extent and severity of physical disease. Some day we will speak in familiar terms of normal and abnormal polarity when discussing matters of pathology.

"Life manifests the same characteristics as do magnets, and electrified bodies. Sex is a matter of polarity; it can be demonstrated by suitable devices. The right hand of a man is positive, the right hand of a woman is negative. The right eye of a man is positive, the right eye of a woman is negative. Speaking in general the body of a male is positive, and that of the female negative, altho in each the organs have positive and negative poles of opposite character according to sex, the only exceptions being the heart, the right side of which is positive, and the left side of which is negative in both sexes, and the large arteries and veins, the first being positive and the latter negative. The veins in both sexes are negative. For the rest the polarities of the two sexes are opposite. Dr. Albert Abrams of San Francisco, Calif., and others have done a great deal of work in this field," he explained.

"How is this possible if it is not due to the iron in the substance of the tissues?" I urged.

"All matter conducting electric energy shows polarity, which is only another way of saying that it has a point of taking in, and giving off energy. The polarity is both magnetic and electric, due to the electric currents set up in the organism as a result of magnetic transformation. The contact of the sexes is necessary for the complete oxidation of the system as well a for procreative purposes. The meeting of suitable polarized individuals stimulates the metabolism of both and soon becomes evident in an improved physical appearance of the individuals so united. Iron may play a part in it; but much of it is probably due to molecules, the joint molecular weight of which falls well within the fifty. Such molecules have a magnetic effect, and doubtlessly play rather a complex part in the mechanics of life."

He removed the nerve fiber from the

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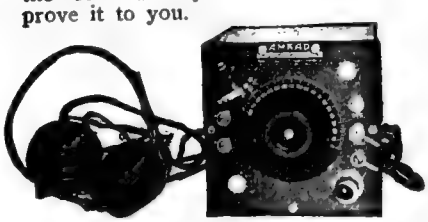

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silk string and attached to it a piece of spleen, explaining that this tissue was comparatively rich in iron, but when he brought the magnet in close proximity, the action while positive, was nevertheless much weaker. "These effects," Doctor Pringle continued, "while positive here, are much more so in the living organism. Several prominent physicians are already using this form of energy in their diagnostic work with no little success.

"But what I want to call to your attention, is not the diagnostic value of this force, but rather its physiologic effect. I want to show you that the metabolic and functional activities of various cell groups are stimulated thru the intensification of the magnetic field. For instance, we know that normally the human stomach lies in an atmosphere of tympany, that is, upon percussion it yields a certain degree of resonance. Now if I percuss the stomach of an individual when he faces west and again while he is facing south a perceptible difference in the tone of the organ may be noted by the trained ear. The difference in the direction in which the magnetic lines of the earth traverse the body affects the tonicity of the stomach musculature. You do not consciously experience these effects. That is the reason when I make the bare statement, you are apt to smile, as we all smiled at obscure phenomena before the day of radio-activity.

"Not only does the magnetic field of the earth affect the tonicity of the stomach muscle but its intensification upon the back, at the root of the neck, by means of a powerful electro-magnet will affect the position, not only of the stomach but of the liver and spleen as well.

"Now if magnetism does affect the body cells which are comparatively neutral, how much more will it affect the very susceptible nerve cells thruout the body as well as in the brain. We have seen that the nerves are more susceptible to magnetic action than are the visceral organ, and therefore it is only logical to conclude that the reactions set up by magnetic variations within the brain mass, must be correspondingly more intense as well as more complex than they are in other tissues; that may account for the fact that the brain is the function-governing tissue. If we could compute the effect of the earth's magnetism upon the brain I believe we would find one of the determining causes of human conduct as well as a clue to the real source of energy. But as it is, this universal, uninsulable energy is as yet an unknown factor in the science of psychology and we are to that extent believers in free will."

Returning to the laboratory table he drew to himself a rather complex looking instrument between two poles of which he fastened the sciatic nerve in the muscles of a frog's leg. I noticed that to one of the poles there was attached a small metal arm, the other end of which rested lightly upon a rotating cylinder.

"This is a frog leg receiver," said he, "and the waves traced by this little arm on the smoked surface of the cylinder is a message sent by a British Columbia radio station to Shanghai, China. This experiment was first performed by a French physiologist. He connected the frog leg into a microphone circuit and produced this marvelous proof of responsitivity of the nerve cell to magnetic change.

"Radio waves, as you know are nothing but oscillations in the earth's magnetic field and if they affect the nerve cells in a dead frog's leg how much more must they affect the infinitely greater nerve mass of the human brain. This may explain the phenomena of telepathy, if really it exists, for as Dr. Abrams said

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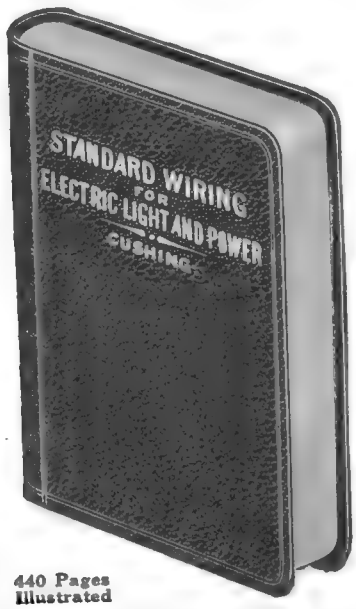

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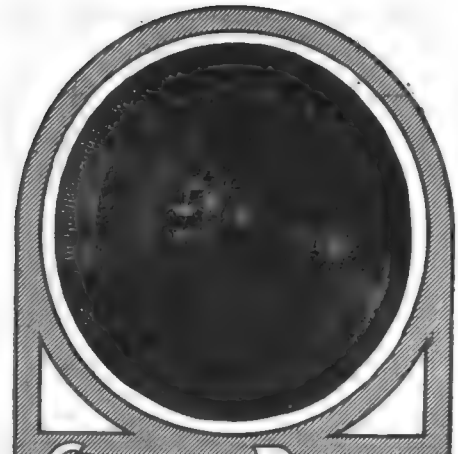

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'all that we know about telepathy is that we know nothing, and we are not even sure of that.' Still it appears to me that the evidence for its existence is quite sufficient to warrant us in accepting the hypothesis of thought transference."

"But how do you explain volition?" I queried, wondering how far he would carry his mechanistic conception of things.

"We will what we must," he answered decisively. "Choice is a delusion due to the fact that we are not conscious of the forces acting upon and thru us. Our will is due to as yet inadequately understood changes in the chemistry of the blood, and, as we know, all chemical action is either due to, or the result of electrical action.

"In the year 1870 Fritsch and Hitzig made an important discovery in brain physiology, when by applying a galvanic current to one hemisphere of a dog's brain they succeeded in producing motion in the muscles of the opposite side of the body. I have experimented a great deal in this field, and have been forced to the conclusion that comparatively weak electric currents will cause the involuntary discharge of certain bodily functions. If a galvanic current thus crudely applied from without will travel down the nerves and act as a motor impulse to the muscles, how much more effective must such an impulse be when born from within in response to the physiologic requirements of the organism.

"It appears to me that the ethero-magnetic impulses stimulate the cells, and that in so doing they are transformed into electronic energy. Perhaps electronic energy developed in the circulation may bring about brain reactions terminating in bodily functions. Be that as it may, I am persuaded that mental phenomena in man, while as yet imperfectly understood, are completely under the domination of natural law. I cannot conceive of man as being the only anarchist in God's Kingdom."

He leaned back in his chair and smoking his cigar, meditatively watched the tiny ringlets as they floated lazily upon the air. He picked up a large magnet and played with it whimsically. I noticed that there was just the faint glint of a smile playing about the corner of his mouth. Evidently he was contemplating another phase of the subject. A moment's silent thought seems to open new vistas of scientific wonders to his mind's eye. He no sooner catches a vision than he takes you with him into it as his mental guest.

Suddenly he whirled around in his swivel chair and remarked: "From your appearance I judge that you are suffering from some chronic malady, the nature of which possibly baffles both you and your physician. Now if you do not mind I will tell you in the latest and most scientific manner just what your disease is, and where it is located, and in doing so, we will step out of consideration of magnetism, and into that of the physical effects of electronic energy.

"If you will strip to the waist and stand upon this zinc plate I will deflect into the body of my Japanese servant the abnormal cell tone to be found in yours."

"Doctor," said I, with mock solemnity, "much reasoning on this subject drives you to madness."

"Ah," he replied, "I wish you were even as I."

At the further end of the laboratory was a low bench extending along the wall, and upon it were two zinc plates to which a small wire chain was fastened. The chain from both plates was attached to a grounded metal. To one of these chains a wire had been attached which connected with a little boxlike affair having a couple of metal levers and a series of buttons

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arranged in circles. He called this little contrivance an "Ohm-meter."

Placing the Japanese on one of these zinc plates, he carefully tapped on his abdomen beginning from the lower portion up, and then from the chest down, and then from the side toward the middle, and as he tapped he marked with a pencil wherever the sounds changed, until he had drawn an odd looking device on the bare abdomen of his subject. "Notice," said he, calling my attention to the figure as well as to the position of his subject. "This boy is standing with his face to the north, now I will place him facing west and we will see what happens." Again he percussed and marked and this time with quite different results.

"You see," he went on, "when the magnetic flux goes thru him sideways the muscle tone is increased, just as it was when I placed a large magnet on his back near the root of the neck. A noted scientist in San Francisco has demonstrated that a concentration of magnetism will affect the stomach dullness of people at a considerable distance.

"Please stand on that other plate and face west," he urged and as I did so, he once more belabored the abdomen of the Jap, and traced out the area of "dullness." It was distinctly different from what it had been on former trials. Untrained as I was, I could clearly notice the slight but distinct alteration in sound.

"You have had malaria," announced Doctor Pringle. "The rate of electronic vibration transmitted from your body over the conductor reveals that condition in this healthy subject."

I was amazed, for more than twenty years ago I really had suffered with malarial chills and since then, with a variety of slight, but nevertheless troublesome symptoms.

"Now then," said Doctor Pringle, "we have seen that the cell is influenced by light in the lower animals, and that magnetism affects the higher animals, and now I will give you a little demonstration that tends to prove that all cells are basically the same, for, as you shall see, light also affects your organism to different extents according to the color and intensity of the light employed."

Placing me in another position he darkened that part of the laboratory and proceeded to drum on my abdomen, while the Jap threw red, blue, green, orange, and other shades of light upon that part of my anatomy, and with each change of light there was a change of tone in the percussion sound.

"Yes, you have had malaria," he reaffirmed; "the Star-White light method of diagnosis verifies the findings of the electronic method of Abrams. It is positive."

And so it was, as I was forced to admit.

While I was replacing my garments after this scientific ordeal, the Doctor admitted the light into the laboratory and began replacing the tools he had used in his experiments. While busy with these things he remarked, "I have told you a good deal about these forces that continually play upon us without our knowledge, yet it is true that more of these forces unite and blend together in the phenomena of life than anywhere else in the physical or chemical universe. Life may be the word of creation, the process of ether becoming matter. I sometimes call it the borderland between the etherial and the concrete. Life and mind do not come out of the earth, but mingle with it, and express themselves thru certain elements of it, giving rise to organic forms. And yet Bose may be right that all matter may be the result of life.

"To make a long story short, mind and life are two phases of the same thing. They are the positive and the negative poles of 'creative force.' This force

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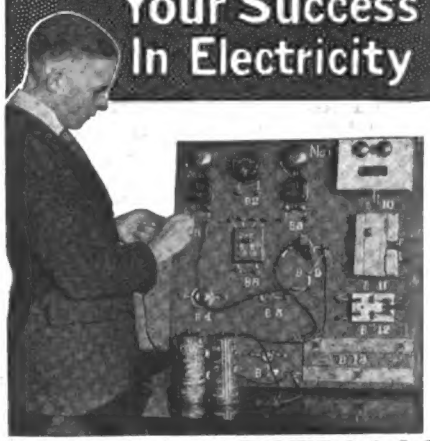

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"The facts that light affects magnetism and magnetism gives rise to electricity and electricity gives rise to atoms, and that gravitation affects them all according to mass and distance, and that none of these forces are constant, lie at the bottom of that complexity of phenomena we call mentality or mind. If we could only measure them accurately enough we could then determine what any brain mass or type would do under any given set of circumstances.

"I have not yet shown you my exeriments in raising plants and animals under differently colored lights. You ought to stay with me a week so that I could give you a better idea of what I am trying to accomplish, but for today we have had enough. Let us go upstairs and see what mother has for the inner man."

Ozone and Its Liquid State

By JOSEPH H. KRAUS

(*Continued from page* 1204)

The cooled air then passes thru one compartment of a two-walled tubular coil thru the other compartment of which, cold nitrogen coming from the ozonizer flows. The effect of the nitrogen is to further cool the air. From here, the cold air passes to an expansion engine where it is relieved of its pressure and assumes a pressure substantially the same as in the atmosphere, and consequently, due to this sudden expansion, it is greatly reduced in temperature and brought to a pre-determined temperature heretofore specified, namely to a point below the liquefication temperature of ozone, but above the liquefication points of both oxygen and nitrogen.

The result is that certain gases in the air will liquefy, such as, for instance, carbon dioxid. This is drawn off in the trap suitably arranged for that purpose, and the liquid carbon dioxid is again used in the dryer.

We now come to the final stage of the process, and perhaps the most important, where the oxygen is converted into ozone, and after being so formed, immediately liquefies. This apparatus, consists of a number of double walled tubes, lined inside and out, as shown in the diagram, with a coating of metal, capable of conducting a current or accumulating a charge of electricity.

The air passing between these walls, changes its oxygen to ozone whenever a high enough potential of electricity is being applied to the metallic electrodes in the ozonators. Due to the extremely low temperature, liquid ozone falls to the bottom of the tank and yet no other gas liquefies. It then circulates into another compartment below the tank, where it is kept cold by nitrogen circulating thru that compartment in coiled tubes.

It can now be drained off whenever required. We are thus able to obtain a liquid ozone, 100 per cent pure, and do not need to quote its concentration in grams per cubic meter.

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William W. Coblentz is a native of Ohio. He has been attached to the Bureau of Standards for twelve years and has developed a method of measuring radiant heat by infra-red and ultra-violet rays. He has devised an instrument for astronomers with which to measure heat from the stars, and also developed in the course of the war signal instruments for ships at sea and an instrument for detecting moving bodies, such as ships, by their heat emanations in the dark.

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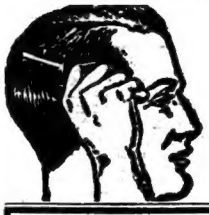

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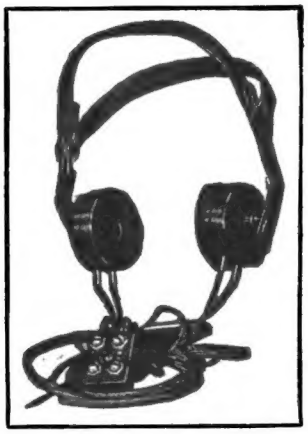

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